

Parenting, Attachment Security and Adjustment Outcomes: The Role of Nonshared Environment

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Thesis declaration form

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Overview

A great deal of research has focussed on uncovering the antecedents of human behaviour. Studies have implicated parenting as having a fundamental impact on the developmental trajectories of children from the moment they are born, through infancy, adolescence, and their journey to adulthood. This thesis will explore the relationship between parenting and outcomes for children through to adolescence.

Part one is a review of the literature examining the evidence for the association between differential parenting and differential adjustment outcomes in externalizing behaviour, internalizing behaviour, temperament, social, and cognitive domains. The review addresses the key question, 'is differential parenting associated with differential outcomes for children growing up in the same family?'. Part two of the thesis presents the empirical paper for a cross-sectional study observing the association between relative differences in parenting and relative differences in attachment security in a sample of monozygotic twins. The study used a monozygotic twin difference design to also examine differences in parenting and differences in adjustment outcomes in the sample, as well as differences in attachment security and adjustment outcomes. Part three is a critical appraisal of the research, reflecting on the process of the preparation, formation and conducting of the study. The impact of the design and methods on the findings are considered, as well as the researchers' subjectivity.

This thesis formed part of a joint project carried out in conjunction with another researcher (Glazebrook, 2015). Joint work included establishing the coding schemes and coding the video recordings of the parent-adolescent dyads (see Appendix for full details).

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Part 1: Literature Review

Differential Parenting and Child Development Outcomes

Abstract

Aims Differential parenting has been proposed as a significant factor in why children in the same family grow up differently, and has been associated with a large range of child development and adjustment outcomes. This review sought to examine the evidence concerning the role of differential parenting in children's socio-emotional adjustment to evaluate whether the presumed significance of differential parenting is indeed supported by existing evidence.

Methods A systematic literature search of major databases identified 17 published papers which used a MZ twin difference design to observe differential parenting and adjustment outcomes. Published papers with $n > 50$ were included.

Results There was evidence for a wide range of associations between differential parenting behaviours and externalizing behaviour, internalizing behaviour, temperament, social, and cognitive outcomes. Longitudinal studies were able to make causal links between parenting and adjustment outcomes, as well as identifying bidirectional relationships.

Conclusions Unexpected findings of child-driven effects and bidirectional relationships between parental and children's behaviour were discussed. The review highlighted possible influential periods of development during adolescence when parenting maybe most important. Limitations of the review were discussed, as well as implications of the study and recommendations for future research.

Introduction

Differential parenting has been an important area of investigation for researchers interested in understanding the factors that influence children's developmental outcomes (Feinberg & Hetherington, 2001). Studies of families and twins provide evidence to support the role of genetics in the transmission of child and adolescent developmental outcomes (e.g. Thapar & McGuffin, 1996); however, it has been shown that family interpersonal environments are likely to contribute to child development outcomes (Feinberg & Hetherington, 2001) and lead to differences between siblings in their developmental outcomes. In this review, the evidence concerning the role of differential parenting in children's socio-emotional adjustment is examined to evaluate whether the presumed significance of differential parenting is indeed supported by existing evidence.

Behavioural genetic studies

Children who have been raised in the same family, with the same parents, are often markedly different from one another. These differences can lie in their personality, cognitive ability, and psychopathology (Pike, Reiss, Hetherington & Plomin, 1996). Differences in siblings are in part due to differences in their genetic makeup, ages and sometimes sex. However, significant differences can still be seen between monozygotic (MZ) twins; who share 100% of their DNA and so are identical genetically, as well as in age and sex (Caspi et al. 2004). Quantitative genetic studies, such as twin and adoption studies, have emerged recently and have helped to tease apart the genetic and environmental factors in outcomes. Two types of environmental variance, *shared* and *nonshared*, have been identified in quantitative genetic research (Deater-Deckard, 2000). Shared environmental effects operate to make siblings similar in their adjustment outcomes; whereas nonshared environmental (NSE) effects operate to make siblings differ in their outcomes: i.e. environments influence on a child-by-child basis (Plomin, 2011). NSE

processes might include exposure to different environments, or sharing the same environment, but *experiencing* it in a different way; e.g. differential parental treatment of siblings or favouritism. Deater-Deckard (2000) argues that “*shared and nonshared environment should not be thought of as separate factors, but rather distinct effects that can be derived from the same environmental factor*”.

Parenting

Behaviour genetics studies have demonstrated that the *nonshared environment* accounts for the majority of the variance in developmental outcomes and differential parenting behaviour has been studied as one likely source of this variance (Deater-Deckard et al., 2001). Considering the critical nature of parenting as a behaviour, there is a great deal of diversity in specific parenting practices. This diversity appears to have important consequences for offspring outcome (Klahr & Burt, 2014). Parenting has been shown to be perhaps the most robust predictor of a wide range of adjustment outcomes in youth. A wide range of studies have demonstrated a consistent association between early parenting and both internalizing and externalizing forms of psychopathology (Klahr & Burt, 2014).

Monozygotic twin difference designs

Although modest to moderate NSE influences have been found for nearly every psychological and behavioural attribute that has been studied (Plomin & Daniels, 1987), specific sources of these NSE effects have only recently started to be identified (Mullineaux, Deater-Deckard, Petrill, & Thompson, 2009). Pike et al. (1996) introduced the monozygotic (MZ) twin difference study design as a powerful tool for identifying specific NSE influences related to adjustment. MZ twins are genetically identical and as such, differences in their behaviour and adjustment cannot arise from differences in their genes, age or sex. Thus, these differences can be directly attributed to NSE (and measurement error). The MZ twin difference design uses relative difference scores to correlate MZ twin differences in

experience with MZ twin differences in outcome, resulting in a strong, unambiguous test of environmental experiences independent of genetics (Caspi et al., 2004). It rules out two other possibilities found in other genetically informative designs: a) that a genetically transmitted liability explains both the parenting of the mother and the behaviour of the child and b) that genetically influenced differences between children evoke different parenting behaviours (Caspi et al., 2004).

Measuring parenting

Parenting has been studied using a large number of measured variables e.g. *warmth, negativity, harsh discipline, control* (Caspi et al., 2004; Deater-Deckard et al., 2001). These can be broadly categorised into three types of behaviour: “*negative*” e.g. negative affect, hostile or coercive behaviour; “*disengaged*” e.g. neutral affect or lack of involvement with their child; or “*positive*” e.g. warmth, affection, positive affect (Lovejoy, Graczyk, O’Hare & Neuman, 2000). *Differential parenting* indicates scenarios where a measured variable is not found to be equal between two siblings. Studies which measured any of these variables through observational and self-report measures were included. This included child, parent, observer and teacher report measures.

Relevance of the current review

There have been a large variety of studies into the influence of parenting on child developmental outcomes. Studies have started to elucidate the specific nonshared aspects of parenting which can make two siblings grow up very differently to each other. There is a need for an overview of these studies; to see whether a) the evidence consistently favours the view that differential parenting is developmentally important for children, b) which particular aspects of parenting are having an influence on developmental outcomes, and c)

what kinds of outcomes are most consistently influenced by differential parenting. Understanding these salient aspects of parenting has important applications in informing clinical work e.g. interventions targeted at families with children at risk of developmental maladjustment. The current review was undertaken to address this need. Studies were included where a measure of parenting was made, as well as measures of differential developmental outcomes between twins. Only studies with MZ twin difference designs were included to look at specific nonshared environmental influences on development. A number of outcome domains were examined to capture the variety present in the literature. The key question addressed in this review was *how does differential parenting affect adjustment outcomes of children in the same family?*

Method

Search strategy

A systematic literature search was conducted including the databases PsycINFO, Medline and Embase. Relevant studies were identified by searching combinations of relevant keywords (i.e. *differential parenting, differential treatment, parenting practices, parenting*) with genetically informative study keywords (i.e. *MZ twin differences, monozygotic twin differences, twin discordance, discordant twins, identical twins, twins*). Additional search terms were added after analysis of initial retrieved papers to further expand results; including adding the terms *maladaptive parenting* and *child rearing practices*. A 'subject headings' search was carried out concurrently using the terms *parenting* and *twins*. The reference sections of all identified articles were examined in order to identify any further studies of interest. The papers identified from these searches were

then reviewed for more detailed evaluations and were included if they met the selection criteria described below.

Inclusion criteria

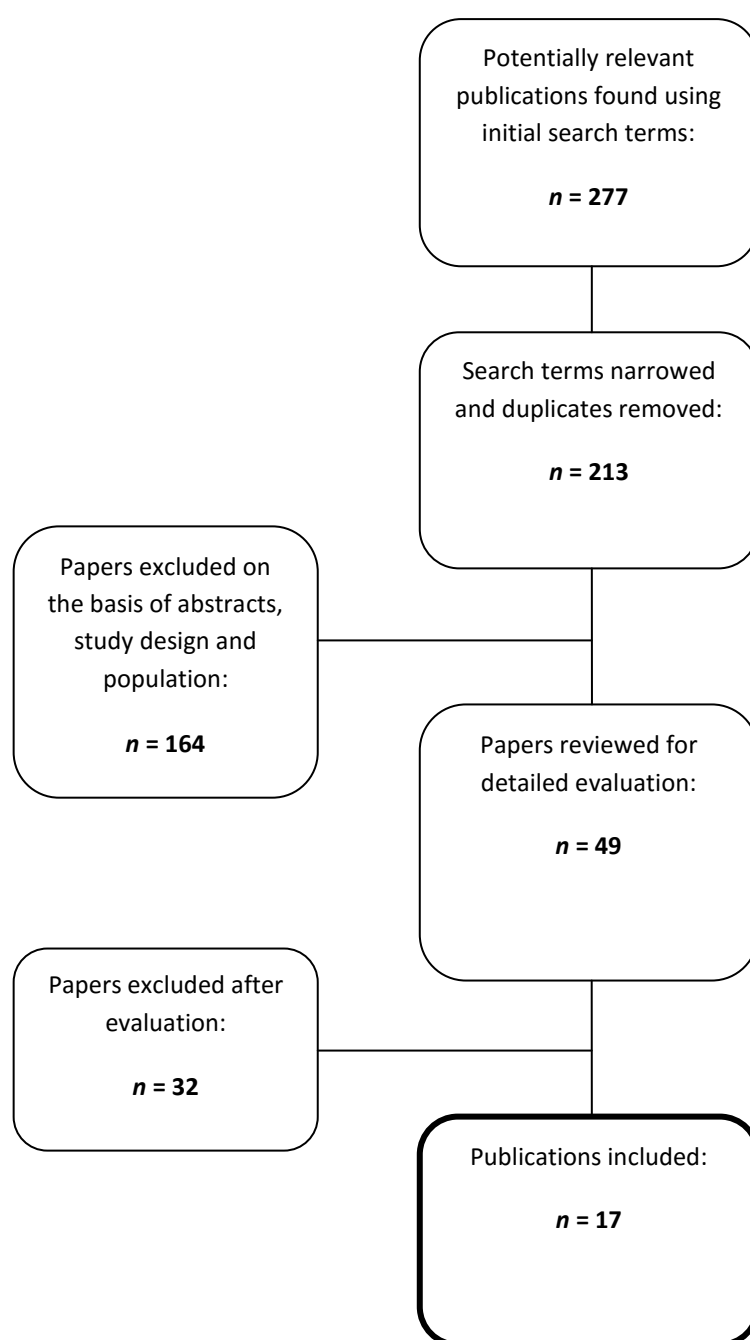
Outcomes may be behavioural, cognitive or social. A large variety of outcomes were observed, which were categorized into broad groups: externalizing behaviour, internalizing behaviour, temperament, social and cognitive outcomes. Studies were included with any age of data collection to provide the widest selection of literature. Included papers were required to have a monozygotic twin differences design. Studies used various ways to statistically analyse MZ twin differences. Including only MZ twin difference designs reduced heterogeneity between studies allowing easier comparisons between them. Studies which focussed on clinical samples in which parents or children were selected due to psychopathology were not included in the review as these samples may show different patterns to non-clinical groups. Conference abstracts for which no full study published article could be found were excluded (2 conference abstracts were excluded). Studies with $n < 50$ MZ pairs were excluded (1 study). Figure 1 provides a diagrammatic representation of the process of retrieval.

Results

Selection of studies

A total of 277 potentially relevant papers were found using the search terms above. This was narrowed to 213 as search terms were refined and duplicates were removed. 164 papers were then excluded upon examination of titles and abstracts which indicated they

Figure 1: Process of retrieval of publications for review



were not relevant (e.g. non-empirical papers, single-case studies). A total of 49 publications remained and these were appraised in more detail for relevance to the current review. This included analysing reference lists to search for additional papers which may meet selection criteria. Seventeen papers remained which met inclusion criteria. Key reasons for exclusion

included non-MZ twin difference designs, no parenting measure, and small sample size ($n < 50$).

The samples used in the selected studies were all extracted from large concurrently running studies of twins. Three of the 17 papers did not provide any further details regarding the original project (Deater-Deckard et al., 2001; Kendler & Gardner, 2001; Mullineaux, Deater-Deckard, Petrill, & Thompson, 2009). Two papers (Burt, McGue, Iacono, & Krueger, 2006; Spanos, Klump, Burt, McGue, & Iacono, 2010) drew samples from the Minnesota Twin Family Study (MTFS; Iacono & McGue, 2002). These papers used the same parenting measure, but measured different outcome variables; so both were included for analysis. Four of the 17 papers used samples from the Twins Early Development Study (TEDS; Trouton, Spinath, & Plomin, 2002): Asbury, Dunn, Pike, & Plomin (2003); Asbury, Dunn, & Plomin (2006); Cecil, Barker, Jaffee, & Viding (2012); Viding, Fontaine, Oliver, & Plomin (2009). Although these studies used the same measures for parenting and outcome, there were variances in specific subscales that the studies analysed; and so they were all included for the review. Two papers (Guo et al., 2011; Hou et al., 2013) drew samples from the Beijing Twin Study (BeTwiSt; Chen et al., 2013). These papers used the same parenting measure, but measured different outcome variables; so both were included for analysis. A summary of the design and variables measured in these studies can be seen in a table in the Appendix.

Sample characteristics

Sample size within the publications ranged from 62 to 2353 MZ twin *pairs* with the total number of participants across all studies being 10612. Age at observation and outcome ranged from 30 months to 30.3 years. All but one paper assessed children from the age of 30 months to 18 years; Kendler & Gardner (2001) used an adult sample of female

MZ twins. The TEDS samples (four papers) were described as reasonably representative of the UK population they are drawn from e.g. 92% of mothers are white; 34% of mothers have A-levels (Trouton et al., 2002). Another three studies also used a UK sample described as majority white, middle class, with mixed levels of education. One paper (Caspi et al., 2004) used the Environment Risk (E-Risk) Longitudinal Twin Study (Trouton et al., 2002) sample. This was a sample specifically chosen as “high-risk families” due to the mothers giving birth for the first time when they were 20 years of age or younger. Four papers used similar middle class, mixed-education samples from North America, and one paper (Guimond et al., 2012) used a Canadian sample described as “extremely similar” in its socio-demographic profile to its sample population. One paper (Mullineaux et al., 2009) did not state the origin of its sample but described it as majority white with mixed levels of parental education. The BeTwiSt samples (two papers) were recruited from across the Beijing municipality in China and were described as being made up of 92% Han ethnic origin adolescents; with 90% of families having an average or wealthy economic status and 30% of parents having a college degree or higher (Hou et al., 2013). Yamagata et al. (2013) used a sample from the Tokyo Twin Cohort Project (ToTCOP; Ando et al., 2006). This was a population-based twin registry in the Tokyo area of Japan.

Three papers (Deater-Deckard et al., 2001; Mullineaux et al., 2009; Pike et al., 1996) used observational measures of parenting, involving 10 minute videotaped structured and unstructured tasks; and five papers used a 15 minute semi-structured interview. All papers used either parent or child report questionnaires to measure parenting, aside from Viding et al. (2009) where only a 15 minute semi-structured interview was used. Outcomes were measured by parent, child or teacher report questionnaires in all studies except Guimond et al. (2012), where an observational task was used; and Burt et al. (2006), where mental health disorders were assessed by clinicians.

Assessing quality of included studies

A quality assessment tool was used to provide a standard measure of strength and quality of the reviewed papers, defined as the extent to which design, conduct and analysis minimised error and bias (Kmet, Lee, & Cook, 2004). Each study was evaluated using the *Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields* (QualSyst; Kmet et al., 2004). QualSyst was developed to address the need for standard criteria for simultaneously assessing the quality of diverse study designs, including non-experimental and non-randomised designs. The scoring system is peer-reviewed (Kmet et al., 2004) and based upon established quality assessment tools for quantitative studies (Cho & Bero, 1994; Timmer, Sutherland, & Hilsden, 2003). The full QualSyst assessment procedure for quantitative studies contains 14 criteria. Criteria five, six and seven were excluded as the reviewed papers did not include intervention studies. Each study was scored according to the degree to which they met 11 criteria ('yes' = 2, 'partial' = 1, 'no' = 0) and a total ranking was then calculated for each paper. These rankings are displayed in Table 1, where the 14 assessment criteria are listed along with the scores allocated to each study. For the QualSyst scoring checklist, please refer to the Appendix.

While useful for providing a standard measure of research quality, the QualSyst assessment tool has a number of limitations. As the authors note, the checklist items represent the authors' perception of research quality and given the absence of standard operational definitions of internal validity or a 'gold standard' measure with which to compare the QualSyst tool to, it is difficult to accurately assess the validity of the tool itself. Furthermore, QualSyst was developed using a small sample of test studies with limited assessment of inter-rater reliability. Standard statistical measures have also yet to be established. Finally, the use of summary scores to categorise studies according to quality

can, in itself, introduce bias into a review (Kmet et al., 2004). Given these limitations, the QualSyst scores are used to aid, rather than replace, qualitative assessment of the studies under review.

Table 1: Assessment of quality of studies using QualSyst (Kmet et al., 2004)

	Item number and corresponding score*											
	1	2	3	4	8	9	10	11	12	13	14	Score
Pike et al., 1996	2	2	2	2	2	2	2	2	1	2	2	0.95
Deater-Deckard et al., 2001	2	2	1	1	2	2	2	0	1	2	2	0.77
Caspi et al., 2004	2	2	2	2	2	2	2	2	2	2	2	1
Mullineaux et al. 2009	2	2	0	2	2	2	2	2	1	2	2	0.86
Asbury et al., 2003	2	2	2	2	2	2	2	2	2	2	2	1
Liang & Eley, 2005	2	2	2	2	2	2	2	2	2	2	2	1
Shields & Beaver, 2011	2	2	2	2	2	2	2	2	1	2	2	0.95
Guimond et al., 2012	2	2	2	2	2	2	2	2	2	2	2	1
Spanos et al., 2010	2	2	2	2	2	2	2	2	2	2	2	1
Kendler & Gardner, 2001	1	1	2	2	2	2	2	0	0	2	2	0.73
Viding et al., 2009	2	2	1	2	2	2	2	2	2	2	2	0.95
Cecil et al., 2012	2	2	1	2	2	2	2	2	1	2	2	0.91
Asbury et al., 2006	2	2	2	2	2	2	2	2	2	2	2	1
Burt et al., 2006	2	2	2	2	2	2	2	2	2	2	2	1
Yamagata et al., 2013	2	2	2	2	2	2	2	2	2	2	2	1
Guo et al., 2011	2	2	2	2	2	2	2	2	1	2	2	0.95
Hou et al., 2013	2	2	1	2	2	2	2	2	1	2	2	0.91

*Note: Item numbers 5, 6, and 7 were not used due to not being applicable to the review

Scores indicate the following: 2 = Yes, 1 = Partial, 0 = No

Summary Score, i.e. the sum of the item scores obtained, divided by the total possible score (22).

The papers included in the review were largely of high quality; only three papers fell below a score of 0.91 (Deater-Deckard et al., 2001; Kendler & Gardner, 2001; Mullineaux et al. 2009). All of the studies employed modest to large samples; although this was partially a function of excluding papers with $n < 50$. All the studies (with the exception of Kendler & Gardner, 2001) clearly defined their aims and objectives, and provided a clear description of their study design. All of the selected studies also utilised valid and reliable means of measuring parenting and developmental outcome variables. The studies tended to use standardized measures and reported their psychometric properties. In terms of data analysis; all of the studies used appropriate statistical analyses, reported their results in sufficient detail and made appropriate conclusions supported by their data.

Of particular note when considering quality of research are the Caspi et al. (2004) and Yamagata et al. (2013) papers. These are both elegantly written papers describing very rigorously constructed research studies, with the study data, conclusions and implications communicated very clearly.

The review included only studies with a monozygotic twin difference design. This automatically controlled for a number of variables between pairs of twins; including family background, socioeconomic status, genes, etc. It was felt that a lack of further controlling for confounding variables was not likely to have seriously distorted results, and therefore these studies were scored as “partially” fulfilling criteria as per the scoring guidelines (Kmet et al., 2004). However, some studies took further factors into account and controlled for variables such as birthweight, deviant peer association, negative life events, rater bias, etc.

All of the included studies used different source data as parenting was measured using observations, interviews, self-report and child-report questionnaires; while outcomes also involved a mixture of observations and child, parent or teacher-report measures. Studies varied considerably in the number of parenting variables and outcomes they

measured, and several used multiple reporters and measures to examine the same variable. Studies which used more than one reporter for a variable were able to reduce the risk of rater bias; and studies which used multiple measures for each variable reduced the risk of measurement error.

Several studies which took samples from larger ongoing twin studies (e.g. the TEDS samples, Trouton et al., 2002), referred to other published papers for greater detail on sampling, recruitment, demographic characteristic, etc. This made it difficult to get a full picture of the procedures followed to obtain the sample for the study, as well as the characteristics of the sample.

Assessment of generalisability may take into account the representativeness of the sample (e.g. SES, ethnicity, particular characteristics), the contexts in which data was collected (in this case either in the family home, which is considered to be more ecologically valid, or the laboratory), and the source of data (child-report questionnaires, parent/teacher report questionnaires, observation of interactions, etc.). There was considerable variation between studies regarding these features.

Parenting and child outcomes

Studies are grouped by externalizing behaviour, internalizing behaviour, temperament, social, and cognitive outcomes. The majority of studies reported more than one category of outcome and so are reported in all relevant groups. Where possible, statistical information has been extracted and included below. However, not all papers reported this information, particularly in the case of non-significant values.

Externalizing behaviour

Ten papers included externalizing behaviours as outcomes. Pike et al. (1996) assessed 93 MZ twin pairs (ages 10 to 18 years) separately with their parents in a problem solving task. This was coded using a global coding system from Hetherington & Clingempeel (1992) and the Conflict Tactics Scale (Straus, 1979). Parent, child and observer report was used for all measures. The parenting score measured both maternal and paternal negativity in the form of punitiveness; yielding to coercion; conflict; and symbolic aggression. Externalizing behaviour outcomes were assessed using two measures for antisocial behaviour: the Behaviour Problems Index (BPI; Zill, 1985), antisocial subscale; and the Behaviour Events Inventory (BEI; Patterson, 1982), antisocial subscale. The authors analysed the data by correlating the relative difference score of the parenting both twins received to the relative difference score in each outcome variable. Maternal negativity was significantly correlated with antisocial behaviour in each of the within-reporter measures, ranging from $r = .27$ to $.33$, $p < .05$, indicating that the twin who experienced more maternal negativity was more likely to present with antisocial behaviour than their co-twin who experienced less maternal negativity. The total composite measures of maternal negativity and antisocial behaviour were correlated moderately ($r = .28$, $p < .05$). Equivalent paternal data was also collected and was found to be similarly correlated in each of the within-reporter measures, ranging from $r = .29$ to $.54$, $p < .05$, with the total composite measures correlated at $r = .34$, $p < .05$.

Deater-Deckard et al. (2001) assessed 62 MZ twin pairs (age $M = 43$ months) separately with their primary caregiver (almost always the mother) in a structured and an unstructured task. Parenting was coded using the Parent-Child Interaction System (PARCHISY; Deater-Deckard, Pylas, & Petrill, 1997); and a global coding system of harshness of discipline (Deater-Deckard, Dodge, Bates, & Pettit, 1996) following a 15 minute semi-

structured interview. The Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996) was also administered to further assess parenting. The parenting score measured harsh discipline; negativity; positivity; positive control; negative control; responsiveness; and on-task behaviour. Outcomes were assessed using a measure of emotional adjustment; the Total Problems score of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). This measure included a scale for internalizing behaviour (Emotional Problems). Observer-rated harsh discipline, self-reported negativity and positivity and observed positivity were all found to have a significant association with the SDQ Total Problems score ($r = .36, .47, -.43, -.29, p < .01$, respectively). This result indicated that the twin who experienced more harsh discipline and maternal negativity was more likely to have behavioural problems as measured by the SDQ than their co-twin who experienced less harsh discipline and maternal negativity.

Caspi et al. (2004) assessed 565 MZ twin pairs at age 5 years and at 7 years. Mothers were asked to freely describe their children in a Five-Minute Speech Sample task (Magaña et al., 1986) designed to elicit expressed emotion about each child. The parenting score measured positive comments; negative comments; negativity; and warmth. Externalizing behaviour outcomes were assessed at ages 5 and 7 years using the Delinquent Behaviour and Aggressive Behaviour scales of the Child Behaviour Checklist (CBCL; Achenbach, 1991a) and the Teacher Report Form (Achenbach, 1991b). Differences in all measures of maternal expressed emotion towards their child (number of negative comments, negativity, number of positive comments, warmth) were significantly correlated with differences between the MZ twins' behaviour problems both cross-sectionally (at 5 years), $r = .53, .49, -.22$, and $-.28, ps < .01$ respectively) and longitudinally (at 7 years, $r = .35, .33, -.20$, and $-.23 ps < .01$ respectively). At 5 years; number of negative comments, negativity, number of positive comments, and warmth were significantly associated with twin differences in antisocial behaviour problems at $r = .53, .49, -.22$, and $-.28, p < .01$

respectively. At 7 years; these measures were again significantly associated at $r = .35, .33, -.20$, and $-.23, p < .01$. These results demonstrated that the twin receiving more maternal negativity and less maternal warmth at age 5 had more antisocial behaviour problems at age 7 than the other twin. Regression analyses were carried out predicting behavioural differences between the MZ twins at age 7 as a function of differences in their mother's expressed emotion toward them when they were 5 years old, after controlling for age 5 behavioural differences. Regression coefficients continued to be significant for all measures ($\beta = .16, .16, -.11$ and $-.11, p < .01$ respectively), suggesting a causal link between maternal expressed emotion and children's antisocial behaviour problems.

Mullineaux et al. (2009) assessed 77 MZ twin pairs (ages 4 to 8 years) separately with their mother in two cooperative tasks on two occasions, one year apart. Parenting was coded using the Parent-Child Interaction System (PARCHISY; Deater-Deckard et al., 1997); and the Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996) was also administered. The parenting score measured positivity; positive control; responsiveness (composite score: *maternal positivity*); negative control; negativity (composite score: *maternal negativity*). Externalizing behaviour outcomes were assessed at both time points using the Externalizing (aggressive and non-aggressive conduct problems) scales of the Child Behaviour Checklist (CBCL; Achenbach, 1991a). Maternal negativity had modest significant correlation with externalizing behaviour both cross-sectionally (at 4-8 years) and longitudinally (at 5-9 years), $r = .29$ and $.20, p < .01$ and $p < .05$ respectively. Maternal positivity also had modest significant correlation with externalizing behaviour both cross-sectionally and longitudinally, $r = .23$ and $.21, p < .05$ respectively. The same associations were found in analysis of change scores. These results demonstrated that at both time points, the twin who received more maternal negativity showed more externalizing behaviour; and this association endured over time. However, only one between-informants rating was found to

be significant (negativity-externalizing at Time 2: $r = .21$, $p < .05$), but this association did not endure over time.

Asbury et al. (2003) assessed 2353 MZ twin pairs (age 4 years) from the TEDS sample with their primary caregivers (usually their mother). Parenting was coded using a global coding system of harshness of discipline (Deater-Deckard, Dodge, Bates & Pettit, 1998) following a 15 minute semi-structured interview; and the Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996) was also administered. The parenting measures were composited to provide a score for *harsh parental discipline* and *negative parental feeling*. Externalizing behaviour outcomes were assessed using the Hyperactivity and Conduct Problems scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Harsh parental discipline had modest significant correlations with both hyperactivity and conduct problems ($r = .18$ and $.24$, $p < .01$ respectively). Negative parental feeling also had modest significant correlations with both hyperactivity and conduct problems ($r = .17$ and $.29$, $p < .01$ respectively). These results indicated that the twin who experienced more harsh discipline and negativity showed more externalizing behaviour. The paper reported average effect size (squared correlation) of 2% for harsh parental discipline and 4% for negative parental feelings. Asbury et al. (2003) also analysed the 10% most extreme behaviour-discordant pairs and the 10% most extreme parenting-discordant pairs. The established significant correlations were found again, but with stronger associations (an effect size of 9% for the behaviour-discordant sample and 12% for the parenting-discordant sample). This indicated that there may be a greater effect of parenting at extremes of behaviour.

Viding et al. (2009) also assessed 2254 MZ twin pairs (at ages 7 and 12 years) from the TEDS sample with their primary caregivers. Parenting was coded using the global coding system of harshness of discipline (Deater-Deckard, et al., 1998), providing a score for

negative parental discipline. Externalizing behaviour outcomes were assessed using the Conduct Problems and Callous-Unemotional traits scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Negative parental discipline had modest significant correlation with conduct problems both cross-sectionally (at 7 years) and longitudinally (at 12 years), $r = .46$ and $.20$, $p < .001$ respectively. Negative parental discipline also had modest significant correlation with callous-unemotional traits both cross-sectionally and longitudinally, $r = .27$ and $.06$, $p < .001$ and $p < .05$ respectively. Teacher ratings also found similar correlations, but with a weaker association (aside from negative discipline/callous-unemotional traits, which was not found to be significant). Regression analyses predicting conduct problems at age 12 controlling for age 7 conduct problems found a significant association ($\beta = .07$, $p < .01$); but the same was not found for callous-unemotional traits ($\beta = .03$, *ns*). These results demonstrated a longitudinal association between negative parental discipline and conduct problems. The twin who had received more negative parental discipline at age 7 showed higher levels of conduct problems at age 12 than their co-twin. This association held even after the initial twin differences in conduct problems at age 7 were controlled for in analyses.

Cecil et al. (2012) also assessed 2092 MZ twin pairs (at age 3, 4, 7, 9, and 12 years) from the TEDS sample with their primary caregivers (usually their mother). Parenting was coded using the global coding system of harshness of discipline (Deater-Deckard et al., 1998) and the Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996). These parenting measures were composited to provide a score for *harsh parenting* and *negative parental feeling*. Externalizing behaviour outcomes were assessed at 12 years by teacher report using the Conduct Problems scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). A composite measure of *self-control* was created using parental ratings of child characteristics at 3, 4, 7, and 9 years; which included dimensions of inattention/hyperactivity, persistence and emotional regulation. Two cross-lagged models

were estimated, one for MZ difference scores for harsh parenting and self-control and one for MZ difference scores in negative parental feelings and self-control. Results demonstrated significant bidirectional effects of differences in self-control and harsh parenting in early childhood. Twins who experienced higher levels of harsh parenting at 3 years were more likely to have lesser self-control at age 4 than their co-twin, beyond baseline differences in self-control ($\beta = -.07, p < .01$). Alongside this, twins who had higher self-control at age 3 years experienced lower levels of harsh parenting at age 4 years ($\beta = -.07, p < .01$). This bidirectional effect continued up to 7 years. The results demonstrated that higher levels of harsh parental discipline during early childhood resulted in lower levels of self-control throughout development in mid-childhood; as well as showing that lower self-control in children can evoke harsher discipline from parents. Between 7 and 9 years, the twin with higher levels of self-control experienced significantly less levels of harsh parenting ($\beta = -.07, p < .05$). However, the opposite effect of lower levels of self-control was not predicted by higher levels of harsh parenting between 7 and 9 years ($\beta = -.04, ns$). At age 12 years, conduct problems were predicted by higher levels of harsh parenting at age 9 ($\beta = .14, p < .01$). The twins with higher levels of self-control at age 9 years had significantly lower levels of conduct problems at age 12 years, for both the harsh parenting and negative parental feelings models ($\beta = -.14$ and $-.17$ $ps < .001$ respectively). Examining gender differences for this association revealed this was only significant for boys and not girls.

Higher levels of negative parental feelings at age 3 predicted lower levels of self-control at age 4, beyond baseline differences in self-control ($\beta = -.07, p < .01$). The same significant effect was found between 4 and 7 years; however, this did not continue between 7 and 9 years. Lower self-control at 4 years predicted higher levels negative parental feelings at 7 years ($\beta = -.07, p < .001$), indicating a child evocative process. The study found a significant bidirectional relationship between negative parental feelings and

self-control; but only between the ages of 4 and 7 years. Negative parental feeling was not significantly associated with conduct problems.

Asbury et al. (2006) again assessed 2017 MZ twin pairs (age 4 years) from the TEDS sample with their primary caregivers (usually their mother). Parenting was coded using the global coding system of harshness of discipline (Deater-Deckard et al., 1998) and the Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996); providing a score for *harsh parental discipline* and *negative parental feeling*. Factor analysis of a series of questions answered by parents about how they talk to their twins yielded two factors which were also used to assess parenting: *instructive parent-child communication* and *informal parent-child communication*. Externalizing behaviour outcomes were assessed using teacher ratings of the Hyperactivity and Conduct Problems scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Harsh parental discipline had very modest significant correlation with conduct problems ($r = .07, p < .05$), indicating that the twin who experienced more harsh parental discipline was more likely to have conduct problems than their co-twin who experienced less harsh parental discipline. A very modest correlation was also found for parental discipline and hyperactivity for girls ($r = .09, p < .05$). Negative parental feeling was not found to be significantly correlated with either hyperactivity or conduct problems ($r = .02$ and $.02, ns$). Instructive parent-child communication had very modest significant correlation with hyperactivity and conduct problems ($r = .10$ and $.08, p < .01$ and $p < .05$ respectively). Instructive parent-child communication showed no significant correlations with hyperactivity or conduct problems. The authors also analysed the 10% most extreme behaviour-discordant pairs and the 10% most extreme parenting-discordant pairs. Instructive parent-child communication was associated with discordant hyperactivity and conduct problems in these extreme samples, accounting for 6-8% of the variance. Discordant parental discipline accounted for 5% of the variance in conduct problems. These small but significant associations suggest that more instructive parent-child communication

at age 4 may have a small causal role in hyperactivity and conduct problems in middle childhood.

Burt et al. (2006) assessed 486 MZ twin pairs (at ages 11, 14 and 17 years) from the MTFs sample with their mothers. Parenting was assessed by parent and child report using the Parent-Child Conflict Scale from the Parental Environment Questionnaire (PEQ; Elkins, McGue, & Iacono, 1997), giving an overall score for *parent-child conflict*. Externalizing behaviour outcomes were assessed using the Diagnostic and Statistical Manual (DSM-III-R; American Psychiatric Association, 1987) criteria for mental disorders; and assessment of Conduct Disorder and Oppositional Defiant Disorder using the Diagnostic Interview for Children and Adolescents-Revised (DICA-R; Reich & Welner, 1988). Parent-child conflict was found to have modest significant correlations with externalizing behaviour at ages 11, 14 and 17 ($r = .16, .21, \text{ and } .16, p < .05$ respectively). These results indicated that the twin who experienced more parent-child conflict was more likely to exhibit externalizing behaviour at those specific ages. However, the cross-lagged model over the three time points did not reveal any significant correlations in the cross-lagged paths. These results indicate that for a general sample, most of the association between differential parent-child conflict and differences in adolescent outcomes is age specific and does not hold over time. The authors also analysed the 10% most extreme behaviour-discordant pairs and the 10% most extreme parenting-discordant pairs. The cross-lagged model found differential parent-child conflict at age 11 years uniquely predicted differential externalizing behaviour at age 14 years, accounting for 3.8-6.7% of the variance. This positive association indicated that the twin experiencing the most conflict exhibited higher levels of externalizing behaviour three years later. However, this association did not persist beyond this particular developmental period.

Hou et al. (2013) assessed 520 MZ twin pairs (age 10 to 18 years) with one of their parents at two time points with a 2 year gap. Parenting was assessed by adolescent report using scales adapted from the Iowa Youth and Families Project (Conger, Patterson, & Ge, 1995), giving scores for two dimensions of parenting: *parental warmth* and *parental hostility*. Externalizing behaviour outcomes were assessed using the aggressive and delinquent subscales of the Youth Self-Report Inventory (YSR; Achenbach & Rescorla, 2001). Cross-lagged models were estimated for MZ difference scores in parental warmth/hostility and externalizing behaviour across the two waves. Twin differences in externalizing behaviours at the first wave significantly predicted differences in both maternal and paternal hostility at the second wave after controlling for stability and deviant peer affiliation ($\beta = .12$ and $.14$, $ps = .05$ respectively). These results gave little support to parental hostility being a nonshared factor of twin differences in externalizing behaviour, but rather indicated a child-driven effect. Parental warmth was not found to have a significant correlation with externalizing behaviours in the cross-lagged model. The findings indicated that each twin creates their own environmental niche in family contexts based on their pre-existing externalizing behaviours (Hou et al., 2013).

Summary: All studies used outcome measures and parenting measures with good psychometric properties (e.g. SDQ and PFQ). One of the studies had a non-normative sample including at risk children (Caspi et al., 2004). Each paper in this category found significant modest to moderate associations between differential parenting and various externalizing behavioural outcomes (e.g. aggression, hyperactivity, conduct problems). Four of the ten papers used the large TEDS (Trouton et al., 2002) sample of over 2000 MZ twin pairs. Five of the studies were longitudinal in design, allowing for inferences to be made regarding causal or bidirectional effects. Hou et al. (2013) found evidence for a child-driven effect of externalizing behaviours on parenting in their cross-lagged model, contrary to the expected direction of the effect. Other studies found evidence of bidirectional effects.

Studies which carried out analyses on the most discordant behaviour and parenting twin pairs found greater effects at these extremes. Overall, there appears to be very good evidence for a moderate relationship in these studies with differential parenting and externalizing behavioural outcomes.

Internalizing behaviour

Nine studies included internalizing behaviours as outcomes. Pike et al. (1996) also assessed internalizing behaviour in the 93 MZ twin pairs sample. Outcomes were assessed using three measures for depression: the Behaviour Problems Index (BPI; Zill, 1985), depression subscale; the Behaviour Events Inventory (BEI; Patterson, 1982), depression subscale; and the Child Depression Inventory (CDI; Kovacs, 1983). Maternal negativity was significantly correlated with depression in both within-reporter adolescent and mothers' report measures, ($r = .33$ and $.23$, $p < .05$, respectively), indicating that the twin who experienced more maternal negativity was more likely to present with depression than their co-twin who experienced less maternal negativity. However, the between-reporter correlations approached zero. The total composite measures of maternal negativity and depression were not correlated significantly ($r = .16$, ns), but the composite score of maternal negativity did correlate moderately significantly with the adolescent report of depression ($r = .29$, $p < .05$). Equivalent paternal data was also collected and was found to be very similarly correlated in that both the within-reporter adolescent and fathers' report measures reached significance ($r = .28$ and $.25$, $p < .05$), and the total composite measures did not correlate significantly ($r = .15$, ns). The composite score of paternal negativity was again found to correlate moderately significantly with the adolescent report of depression ($r = .24$, $p < .05$). It was hypothesised that the observed behaviours presented differently across the situations experienced by the different informants, leading to the lack of between-source correlation. Another potential issue may have been rater bias (Pike et al.

1996). As described earlier, the study also found associations between parental negativity and externalizing problems. The associations seen here with internalizing symptoms may have some overlap with the earlier described findings, due to a well established co-occurrence of depression and externalizing problems (e.g. Cutuli, Chaplin, Gillham, Reivich, & Seligman, 2006).

Mullineaux et al. (2009) also assessed internalizing behaviour in their 77 MZ twin pairs sample. Outcomes were assessed at both time points (4-8 years age and one year later) using the Internalizing (anxiety/depression, withdrawal, somatic problems) scales of the Child Behaviour Checklist (CBCL; Achenbach, 1991a). Neither maternal negativity nor positivity were found to have a significant correlation with internalizing behaviour either cross-sectionally (at 4-8 years) or longitudinally (at 5-9 years), $r = -.17$ and $.02$, *ns* respectively. The authors discuss known limitations of measuring children's internalizing problems and the difficulties for adults to reliably assess individual differences in children's depression (Mullineaux et al., 2009).

Asbury et al. (2003) also assessed anxiety in their 2353 MZ twin pairs sample (at age 4 years). Anxiety symptoms were assessed using 4 out of 5 items of the Emotional Problems scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). The correlation between harsh parental discipline and anxiety approached zero ($r = -.03$, *ns*). A very modest significant correlation was found with negative parental feelings and anxiety ($r = .08$, $p < .01$), indicating that the twin who experienced more negative parental feelings was more likely to have problems with anxiety than their co-twin who experienced less negative parental feelings. The authors also analysed the 10% most extreme behaviour-discordant pairs and the 10% most extreme parenting-discordant pairs. A stronger association was found for negative parental feelings and anxiety ($r = .14$ to $.19$, $p < .01$).

Liang & Eley (2005) assessed 328 MZ twin pairs (age 12-19 years) with their parents at two time points, one 6 months after the other. Parenting was coded using the Negative Sanctions and Communication About Discipline subscales from a parent-child relationship measure (Hetherington & Clingempeel, 1992), providing a score for *punitive* and *constructive discipline*. Internalizing behaviour outcomes were assessed using the Moods and Feelings Questionnaire (MFQ; Angold & Costello, 1995); a self-report measure of depressive symptoms. Regression analyses were carried out predicting differences in depression between the MZ twins at Time 2 as a function of differences in parenting at Time 1, after controlling for Time 1 depression symptom differences. Maternal punitive discipline and paternal constructive discipline at Time 2 were both found to be significantly associated with depression at Time 1 ($t = 2.11$ and 2.23 , $ps < .05$ respectively), indicating that the twin who presented with more difficulties with depression was more likely to experience greater maternal punitive discipline and paternal constructive discipline six months later. The authors suggested that this may indicate a shift in parenting discipline following changes in adolescents' behaviour due to depression (e.g. irritability or self-harming behaviour).

Shields & Beaver (2011) assessed 289 MZ twin pairs (age 11-18 years) with their primary caregiver (usually their mother) in two waves, approximately a year after one another. Parenting was coded using maternal disengagement scales, attachment scales and involvement scales which were included in the interviews of the children at both waves. Internalizing behaviour outcomes were assessed using the Centre for Epidemiological Studies Depression scale (CES-D; Radloff, 1977); a self-report measure of depressive symptoms. Maternal disengagement was found to have a moderately significant correlation with depression at Wave 1 ($\beta = .273$, $p < .05$), indicating that the twin who had more problems with depression was more likely to also experience higher levels of maternal disengagement than their co-twin who had less problems with depression. After controlling

for the effects of depression at Wave 1, differences in maternal disengagement at Wave 2 remained a significant predictor of depression at Wave 2 ($\beta = .249, p < .05$). The cross-lagged model over the two time points did not reveal any significant correlations in the cross-lagged paths. A reciprocal effects model showed that differences in maternal disengagement at Wave 2 were unrelated to differences in depression. However, depression at Wave 2 was indeed found to predict maternal disengagement, indicating again that the twin who had more problems with depression was more likely to experience higher levels of maternal disengagement. The authors state that the association between maternal disengagement and depression is accounted for by a purely child-driven effect.

Spanos et al. (2010) assessed 234 female MZ twin pairs (at ages 11, 14 and 17 years) with their mothers. Parenting was assessed by parent and child report using the Parent-Child Conflict Scale from the Parental Environment Questionnaire (PEQ; Elkins et al., 1997), giving an overall score for *parent-child conflict*. Disordered eating was assessed using the Total Score, Body Dissatisfaction, Weight Preoccupation, and Binge Eating subscales of the Minnesota Eating Behavior Survey (MEBS; Garner, Olmstead, & Polivy, 1983). Parent-child conflict was found to have significant within-age correlations with aspects of disordered eating attitudes and behaviours at ages 11, 14 and 17 ($r = .16$ to $.41, p < .05$). These results demonstrated that the twin who experienced more parent-child conflict was more likely to exhibit disordered eating at those specific ages. Across-age associations were contrary to the hypothesised correlations. Parent-child conflict was not found to be significantly associated with later twin differences in disordered eating. Aspects of disordered eating attitudes and behaviours at ages 11 and 14 years were significantly correlated with twin differences in conflict at age 17 years ($r = .15-.27, p < .05$), suggesting that parent-child conflict may be evoked by disordered eating behaviours in the child. The cross-lagged models over the three time points revealed significant associations across almost all *within-age* correlations, indicating a nonshared environmental mediation effect

between differences in disordered eating behaviour and parent-child conflict at the specific ages. However, most of the cross-lagged paths in the models *over the three time points* did not reveal any significant correlations. Total Score and the Weight Preoccupation subscale at age 14 years were found to predict higher levels of parent-child conflict at age 17 years. These results suggest that higher levels of disordered eating behaviours and attitudes during mid-adolescence can lead to higher levels of parent-child conflict during late adolescence.

Kendler & Gardner (2001) assessed lifetime history of Major Depression in their 72 female MZ twin pairs sample (age $M = 30.3$ years). The study analysed an adult sample of MZ twin pairs who were discordant for a lifetime history of depression. Parenting was assessed from child and parent report using the Parental Bonding Instrument (Parker, Tupling, & Brown, 1979), which provided a score for warmth; protectiveness and authoritarianism. Depression was diagnosed by trained interviewers using the Diagnostic and Statistical Manual criteria (DSM-III-R; American Psychiatric Association, 1987). Significant correlations with differences in depression were found with: child-reported maternal warmth ($OR = 0.59, \chi^2 = 3.62, p < .05$), protectiveness ($OR = 2.14, \chi^2 = 7.14, p < .01$) and authoritarianism ($OR = 1.59, \chi^2 = 4.06, p < .05$). Paternal warmth ($OR = 0.43, \chi^2 = 5.21, p < .01$) and protectiveness ($OR = 1.69, \chi^2 = 5.31, p < .01$) were also found to correlate significantly in the child-report measures. The co-twin reports had significant correlations between depression and maternal and paternal protectiveness ($OR = 2.11, \chi^2 = 8.58, p < .05$ and $OR = 1.73, \chi^2 = 5.15, p < .05$, respectively). These results indicate that the twin affected with depression in their lifetime experienced significantly higher levels of parental protectiveness and lower levels of parental warmth. These significant results were also seen when using the report of the unaffected twin on affected twin parenting and depression.

Cecil et al. (2012) also assessed emotional problems in their 2092 MZ twin pairs sample. Internalizing behaviour outcomes were assessed at 12 years by teacher report using the Emotional Difficulties scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). At age 12 years, emotional difficulties were not predicted by higher levels of harsh parenting or negative parental feelings at age 9 years. However, a significant association was found indicating that the twins who had higher levels of self-control at age 9 years had significantly lower levels of emotional difficulties at age 12 years compared to their co-twins who had lower levels of self-control.

Asbury et al. (2006) also assessed anxiety in their 2017 MZ twin pairs sample (at age 7 years). Anxiety symptoms were assessed using 4 out of 5 items of the Emotional Problems scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Anxiety symptom correlations approached zero with all parenting variables: harsh parental discipline, negative parental feelings, instructive parent-child communication, and informal parent-child communication. The analysis of the 10% most extreme behaviour-discordant pairs and the 10% most extreme parenting-discordant pairs also did not reveal any significant correlations.

Summary: All studies used outcome measures and parenting measures with good psychometric properties (e.g. CBCL and PFQ). Two of the studies had a purely female sample (Kendler & Gardner, 2001; Spanos et al., 2010). Three papers in this category found no significant associations or very modest correlations between their variables (Asbury et al., 2003; Asbury et al., 2006; Mullineaux et al., 2009). In these studies, measures for anxiety and a measure for broad internalizing behaviours were found to not have any significant relationships with differential parenting. The other six papers in this category found significant modest to moderate associations between differential parenting and internalizing behavioural outcomes (e.g. depression, emotional problems). Three of the

nine papers used the large TEDS (Trouton et al., 2002) sample of over 2000 MZ twin pairs. Three of the studies were longitudinal in design, allowing for inferences to be made regarding causal or bidirectional effects. There was an apparent trend in some cross-lagged studies of significant effects in unexpected directions. A number of papers had findings which suggested internalizing problems influenced parenting rather than vice versa. Studies also demonstrated time-specific effects which often did not persist over time, suggesting there may be specific periods of time during development where particular effects occur. Asbury et al. (2003) found a slightly stronger association between parenting and internalizing symptoms when analysing the most behaviour and parenting discordant twin pairs. Overall, there appears to be some evidence for a modest relationship in these studies with differential parenting and internalizing behavioural outcomes; but these were not always in the expected direction.

Temperament outcomes

Three studies included aspects of temperament as outcomes. Deater-Deckard et al. (2001) also assessed aspects of temperament in their 62 MZ twin pairs sample (at age $M = 43$ months). Outcomes were assessed using the Parent-Child Interaction System (PARCHISY; Deater-Deckard et al., 1997); providing a score for the child's negativity; positivity; on-task behaviour; non-compliance; activity level; and responsiveness to mother. The Colorado Childhood Temperament Inventory (CCTI; Rowe & Plomin, 1977) provided a score for *emotionality* (labile negative mood). Observer-rated maternal negativity was found to have significant associations with several aspects of twin differences in behaviour: negativity, on-task behaviour, non-compliance, activity levels and responsiveness ($r = .41, -.31, .40, .31, -.22, p < .01$, respectively). This result indicated that the twin who experienced more maternal negativity was more likely to have higher levels of negativity, non-compliance and activity; and lower levels of on-task behaviour and responsiveness to mother than their co-

twin who had experienced less maternal negativity. Observer-rated positive control was found to have moderate significant associations with on-task behaviour, non-compliance, activity levels and responsiveness ($r = .27, -.26, -.24, .27, p < .01$, respectively). This indicated that the twin who experienced more maternal positive control was more likely to have lower levels of non-compliance and activity; and higher levels of on-task behaviour and responsiveness to mother. Harsh discipline, self-reported negativity and positivity had moderate to large associations with emotionality as measured by the CCTI ($r = .38, .59$ and $-.52, p < .01$). This resulted showed the twin who experienced harsher discipline and maternal negativity was more likely to have higher levels of labile negative mood; and the twin who experienced higher levels of maternal positivity was more likely to have lower levels of negative mood.

Mullineaux et al. (2009) also assessed aspects of temperament in their 77 MZ twin pairs sample. Outcomes were assessed at both time points (4-8 years age and one year later) using the Parent-Child Interaction System (PARCHISY; Deater-Deckard et al., 1997); providing a score for the child's negativity; positivity; on-task behaviour; non-compliance; activity level; and responsiveness to mother. These scores were composited to provided two scores for *negative behaviour* and *positive engagement*. Maternal negativity was found to have a moderate significant correlation with differences in negative behaviour at both time points ($r = .24$ and $.25, p = .05$). Maternal positivity was also found to have a large significant correlation with differences in positive engagement at both time points ($r = .45$ and $.59, p = .01$). The same associations were found in analysis of change scores. These results demonstrated that at both time points, the twin who received more maternal negativity showed more negative behaviour than their co-twin who experienced less maternal negativity, and the twin who received more maternal positivity showed more positive behaviour; and these associations endured over time. However, only one between-

informants rating was found to be very modestly significant (maternal negativity-positive engagement at Time 1: $r = .03, p < .05$), but this association did not endure over time.

Guo et al. (2011) assessed 585 MZ twin pairs (aged from 11 to 18 years) with one of their parents. Parenting was assessed by adolescent report using scales adapted from the Iowa Youth and Families Project (Conger et al., 1995), giving scores for four dimensions of maternal parenting: *nurturant-involved parenting*, *harsh-inconsistent parenting*, *maternal warmth*, and *hostility*. The temperament outcome of *effortful control* was assessed using the parent and adolescent-report Early Adolescent Temperament Questionnaire-Revised (Ellis & Rothbart, 2001). Nurturant-involved parenting, harsh-inconsistent parenting, maternal warmth, and hostility were all found to have moderate significant correlation with differences in effortful control using the adolescents' reports ($\beta = .30, -.13, .27$, and $-.27$, $ps = .01$ respectively). Using the parent ratings; nurturant-involved parenting, maternal warmth, and hostility were similarly found to be significantly correlated ($\beta = .16, .10$, and $-.14$, $ps = .01$ respectively). These results demonstrated that the twin who received more maternal nurturant-involved parenting and warmth, and less harsh-inconsistent parenting and hostility, showed a higher level of effortful control than their co-twin.

Summary: All three studies used outcome measures and parenting measures with good psychometric properties (e.g. CCTI and PARCHISY). All the studies used normative samples of MZ twins. Significant moderate to large associations between differential parenting and temperament outcomes (e.g. positive engagement, negativity) were found. Overall, there appears to be good evidence for a moderate relationship in these studies for temperament.

Social outcomes

Five papers included aspects of social behaviour as outcomes. Deater-Deckard et al. (2001) also assessed prosocial behaviour in their 62 MZ twin pairs sample (at age $M = 43$

months). Outcomes were assessed using the Prosocial Behaviour scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Similarly to *emotionality*; harsh discipline, self-reported negativity and positivity had moderate associations with prosocial behaviour ($r = -.27, -.42$ and $.41, p < .05$). This result showed the twin who experienced harsher discipline and maternal negativity was more likely to exhibit lower levels of prosocial behaviour; and the twin who experienced higher levels of maternal positivity was more likely to exhibit higher levels of prosocial behaviour. Observer-rated negative control was also significantly associated with prosocial behaviour ($r = -.25, p < .05$), indicating that the twin who experienced higher levels of negative control was more likely to show lower levels of prosocial behaviour than their co-twin who experienced less negative control.

Asbury et al. (2003) also assessed prosocial behaviour in their 2353 MZ twin pairs sample (at age 4 years). Prosocial behaviour was assessed using the Prosocial Behaviour scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Both harsh parental discipline and negative parental feelings were found to have modest significant correlations with prosocial behaviour ($r = -.16$ and $-.21, p < .01$, respectively). These results showed that the twins that experienced a higher degree of parental discipline or negative parental feelings were more likely to exhibit lower levels of prosocial behaviour. The 10% most extreme behaviour-discordant pairs and the 10% most extreme parenting-discordant pairs were also analysed. The same associations were found, but to a stronger degree ($r = -.31$ to $-.41, p < .01$).

Guimond et al. (2012) assessed 137 MZ twin pairs (age $M = 43$ months) with both their parents. Parenting was coded using the self-report Parental Cognitions and Conduct Toward the Infant Scale (PACOTIS; Boivin et al., 2005). The parenting score measured maternal overprotection, paternal overprotection, maternal hostility and paternal hostility. Social outcomes were assessed using a measure of *social reticence* in a semi-structure play

situation; adapted from the Movie Viewer Situation (MV; Charlesworth & LaFreniere, 1983). For boys, maternal and paternal overprotection were both found to be moderately significantly associated with social reticence ($\beta = .31$, $SE = .15$, $p < .05$ and $\beta = .38$, $SE = .14$, $p < .05$, respectively). These results indicated that the twin boys that experienced maternal and paternal overprotection were more likely to exhibit social reticence compared to their twins. This result was not found in girls; and no other significant associations were found for the parenting variables.

Asbury et al. (2006) also assessed aspects of social outcomes in their 2017 MZ twin pairs sample (at age 7 years). Outcomes were assessed using the Prosocial Behaviour and Peer Relationship Problems scales of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Correlations of prosocial behaviours with parenting variables approached zero and no significant associations were found. Very modest associations were found between both instructive parent-child communication and informal parent-child communication and peer relationship problems ($r = .08$ and $-.08$, $p < .05$, respectively). This indicated that the twin that experienced greater levels of instructive communication at age 4 years was more likely to have higher levels of peer problems at age 7 years; and the twin that experienced higher levels of informal communication was more likely to have lower levels of peer problems at age 7 years.

Yamagata et al. (2013) assessed a sample of 259 MZ twin pairs (at age 42 and 48 months) with their mothers. Parenting was coded using 8 items of the self-report measure from Yamagata (2011). The parenting score measured *consistent discipline*, *harsh parenting* and *authoritative parenting*. Social outcomes were assessed using a measure of peer problems; the Peer Relationship Problems scales of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Twin relative differences in parenting variables showed no concurrent correlation with relative differences in peer problems at 42 months

($r = .00$) and negligible concurrent correlation at 48 months ($r = -.10$ to $-.01$), indicating that the twin with greater levels of peer problems did not have a significantly different experience of being parented than their co-twin with less peer problems. The authors also carried out path analyses on 'synchronous effects' and 'delayed effects' models for the association between peer problems and parenting variables. The *consistent discipline* and *harsh parenting* models were not found to be statistically significant, but the parameters of the models with *authoritative parenting* were. At 48 months, in the synchronous effects model, authoritative parenting concurrently decreased peer relationship problems ($\beta = -.46$, $p < .05$), (indicating that the twin that experienced higher levels of authoritative parenting was more likely to have lower levels of peer problems than their co-twin) and at the same time peer relationship problems increased authoritative parenting ($\beta = -.42$, $p < .05$), (indicating that the twin that had higher levels of peer problems was more likely to experience higher levels of authoritative parenting than their co-twin). This suggested that the previously reported negligible correlation between the two was a result of the negative child and positive parent effects negating each other. The delayed effects model partially supported this finding as the parent effects from authoritative parenting at 42 months to peer problems at 48 months was significant and negative ($\beta = -.21$, $p < .05$). The authors described the results of a factor analysis revealing authoritative parenting as a dimensional concept reflecting the presence consistent discipline as well as an absence of harsh parenting. The findings of this study indicated that authoritative parenting decreased peer problems, and peer problems increased authoritative parenting, resulting in a null correlation between the two.

Summary: All studies used outcome measures and parenting measures with good psychometric properties (e.g. SDQ and PFQ). Guimond et al. (2012) were the only study to use an observational task to measure a developmental outcome (social reticence). One paper in this category found no significant associations or very modest correlations

between their variables (Asbury et al., 2006). This study found a measure for prosocial behaviour did not have any significant relationships with differential parenting, and a measure for peer relationship problems had one very modest correlation. The other four papers in this category found significant modest to moderate associations between differential parenting and social outcomes (e.g. prosocial behaviour, social reticence). Two of the five papers used the large TEDS (Trouton et al., 2002) sample of over 2000 MZ twin pairs. One longitudinal study was able to show a bidirectional effect of authoritative parenting and peer relationship problems. Overall, there appears to be some evidence for a modest relationship in these studies with differential parenting and social behaviour outcomes.

Cognitive outcomes

Asbury et al. (2006) assessed academic achievement in their 2017 MZ twin pairs sample (at age 7 years). This was measured using teacher ratings of child performance on the UK National Curriculum (*QCA National Curriculum handbook for primary teachers in England: Key Stages 1 and 2, 1999*). Only *instructive parent-child communication* (based on three items related to correcting punctuation, sentence structure and vocabulary) was found to be modestly associated with academic achievement ($r = -.13, p < .01$). This indicated that the twin that experienced greater levels of instructive communication at age 4 years was more likely to have lower levels of academic achievement at age 7 years. No other significant associations with parenting variables were found.

Discussion

The aim of this review was to examine published literature of studies using a MZ twin differences design to observe differential parenting and subsequent child development outcomes. Studies which coded specific aspects of parental behaviour were included. Outcomes were measured in a number of domains including externalizing behaviour, internalizing behaviour, temperament, social, and cognitive outcomes.

Summary of findings

All 17 papers in the review found varying degrees of significant associations between differential parenting and child outcomes. The papers reviewed were of high quality, scoring above 0.7 in an assessment of quality (QualSyst; Kmet et al., 2004). Sample sizes were moderate to large, and all papers used valid and reliable measures, describing and justifying their selections appropriately. Twelve of the 17 papers used a longitudinal design, allowing for examination of the temporal order of associations found between variables and enabling causal inferences to be made regarding these associations. Overall, based on the outcome of the above studies, there is good evidence that differences in parenting variables contribute to differential child outcomes across a number of domains. There was also evidence of effects in unexpected directions: studies found bi-directional effects and child-driven effects (i.e. child factors having an effect on parenting behaviour). Key findings from the various domains are discussed below.

Externalizing behaviours

Each paper that examined externalizing behaviour outcomes found significant modest to moderate associations between differential parenting and externalizing outcomes. These outcomes presented the strongest and most consistent associations with

differences in a range of parenting measures. Five of the studies were longitudinal in design, allowing for inferences to be made regarding causal or bidirectional effects. For example, Cecil et al. (2012) found a significant bidirectional relationship between negative parental feelings and self-control, stemming from a child-driven process; but only between the ages of 4 and 7 years. The same was found for harsh parenting. In their cross-lagged model, Hou et al. (2013) also observed an unexpected finding: externalizing behaviours were shown to have a child-driven effect on parenting. Studies which carried out analyses on the most discordant behaviour and parenting twin pairs also showed stronger associations, having a larger effect size than the whole sample.

Internalizing behaviours

Internalizing behaviour outcomes had less clear and consistent associations with differences in parenting. Three papers in this category found no significant associations or very modest correlations between measures for internalizing behaviours and differential parenting (Mullineaux et al., 2009; Asbury et al., 2003; Asbury et al., 2006). The other six papers in this category found significant modest to moderate associations between differential parenting and internalizing behavioural outcomes. Three of the studies were longitudinal in design, allowing for inferences to be made regarding causal or bidirectional effects. Some notable findings arose in these analyses. For example, Liang & Eley's (2005) findings indicated a shift in parental discipline following changes in adolescents' behaviour due to depression (i.e. a child-driven effect). Shields & Beaver's (2011) reciprocal effects model indicated the association between maternal disengagement and depression was accounted for by a purely child-driven effect. These findings suggested internalizing problems may have a stronger influence on parenting than vice versa.

Temperament outcomes

Significant moderate to large associations between differential parenting and temperament outcomes were found. For example, Guo et al. (2011) found that the twin who received more maternal nurturant-involved parenting and warmth, and less harsh-inconsistent parenting and hostility, showed a higher level of effortful control than their co-twin. Mullineaux et al. (2009) carried out a longitudinal study which found an enduring association of the twin who received more maternal negativity showing more negative behaviour; and the twin who received more maternal positivity showing more positive behaviour.

Social and cognitive outcomes

Three of the four papers in this category found significant modest to moderate associations between differential parenting and social outcomes (e.g. prosocial behaviour, social reticence). Asbury et al. (2006) conducted a longitudinal study which indicated a causal link between differential parenting at age 4 and peer problems at age 7. Yamagata et al. (2013) carried out a longitudinal study with synchronous effects and delayed effects models for the association between peer problems and parenting variables. The findings of this study indicated a bidirectional effect: authoritative parenting decreased peers problems, and peer problems increased authoritative parenting. The only study to examine cognitive outcomes, Asbury et al. (2006), showed only instructive parent-child communication was found to be modestly associated with academic achievement.

There are a number of factors which may explain the variation in associations found in these outcomes. These will be explored in relation to their links with existing literature.

Between study factors that may affect associations

Cross-sectional vs. longitudinal designs: an important note

The cross-sectional studies found a large number of modest to moderate associations between a range of variables. Although it is tempting to consider these findings as indicative of an important association between parenting and outcome variables, these studies must be considered with significant caution. The major limitation of these studies is their inability to make inferences regarding causal effects. As such, associations found maybe attributable to a range of other factors. For example, a number of studies found associations between positive aspects of parenting (e.g. warmth) and positive outcomes (e.g. effortful control); as well associations between negative parenting (e.g. harsh discipline) and negative outcomes (e.g. behavioural problems). These findings may simply be attributable to a child-driven effect, whereby the child's behaviour changes how the parent acts and feels towards the child, in positive and negative ways.

Longitudinal studies may be able to start to infer causality in these associations. Using analysis of change scores, Mullineaux et al., (2009) found an enduring association of the twin who received more maternal negativity showing more negative temperament and the twin who received more maternal positivity showing more positive temperament. Although this effect may endure over time, it is not possible from analysis of change scores to detect the direction of the effect. The results of these longitudinal studies are difficult to interpret because the association could be attributed either to *child effects* (i.e. effects of children's temperament on parenting), *parent effects* (i.e. effects of parenting on children's temperament), or both. For example, Asbury et al. (2006) found prospective associations between differential parenting and later peer problems. However, parent and child effects could not be differentiated as cross-lagged models were not used. Yamagata et al. (2013) found parenting variables showed no concurrent correlation with peer problems at 42

months and negligible concurrent correlation at 48 months. The authors then carried out path analyses on 'synchronous effects' and 'delayed effects' models for the association between peer problems and parenting variables. The synchronous effects model suggested that the negligible correlation found between the two was a result of the negative child and positive parent effects 'cancelling each other out'. This was then supported by the delayed effects model. The findings of this study indicated that authoritative parenting decreased peers problems, and peer problems increased authoritative parenting, resulting in a null correlation between the two.

This review has shown that a comparison of both synchronous and delayed effects models is essential in revealing 'pure' bidirectional effects between parenting and outcome variables. Yamagata et al. (2013) were the only study to conduct these models.

Externalizing vs. Internalizing Problems

In this review, the strongest associations were established between differential parenting and externalizing behaviours. These findings maybe a product of the topography of the behaviours being measured. Externalizing behaviour (e.g. antisocial behaviour, conduct problems) is likely to draw a strong reaction from parents, creating a responsive change in their parenting. Longitudinal data supported this explanation, showing a number of child-driven effects for externalizing behaviour. Internalizing behaviour outcomes also had significant modest to moderate associations, but to a lesser degree than externalizing behaviour. Internalizing behaviour (e.g. anxiety, depression) may not result in such a responsive change in parenting behaviour, or may have a withdrawing effect on parenting, e.g. Shields & Beaver's (2011) finding of a child-driven effect of depression on maternal disengagement.

The difficulties for adults to reliably assess individual differences in children's internalizing disorders may be another factor affecting the associations found (Mullineaux

et al., 2009). A number of the studies used only parent or teacher report measures of internalizing behaviour, making it difficult for them to detect a potential outcome.

Externalizing behaviours may have different functions for children at different ages: for younger children externalizing may stem from a drive to seek attention, while in older children it may be seeking confrontation and more hostile. This confrontational behaviour may be more linked to a parent's ability to respond appropriately in a caregiving way. Thus differential parenting may have greater effect at a later age. Further research is needed to explore this possibility and examine the ages at which the links appear.

Some of the studies in the review examining both externalizing and internalizing outcomes found significant associations for both, e.g. Pike et al. (1996) found associations between parental negativity and externalizing as well as internalizing problems. As described early in the results section, a well established co-occurrence of internalizing disorders and externalizing behaviour (e.g. Cutuli et al., 2006) may account for some of variance in these studies.

Raters

Some studies in the review used only one rater for each of their outcome measures. This may have been the child, a parent, a teacher or an observer. A number of studies used multiple raters for some of their measures. Pike et al. (1996) used multiple raters for all their measures: adolescent, mother, father, and observer report. They found significant moderate associations with the majority of within-reporter variables. However, they found very little correlation between raters. This can be understood as factor of differing perspectives; but this needs to be taken into account when considering results. For example, parent ratings will likely be different to child report, as they will be impaired by bias in terms of rating their own parental behaviour and their child's developmental outcome. In this regard, self-report is susceptible to both rater and recall bias. Pike et al.

(1996) found parents of MZ twins have a tendency to think they treat both twins the same, but their adolescents' own perceptions and the observational data found this to be false. So, using only parent report measures may be a significant weakness for MZ twin designs. However, it remains important to record parents' perceptions of their own parenting and perceptions of their children's behaviour, as it may be useful in understanding nonshared environment, even if similar cross-source nonshared environment effects are not found (Asbury et al., 2003).

The use of a single rater or one measure can lead to shared method and shared source variance, and problems associated with these shared variances are well established (Bank, Dishion, Skinner, & Patterson, 1990). A multi-method and multi-source approach would reduce these potential biases. Kendler & Gardner (2001) examined lifetime history of depression in adult MZ twins, using the twins and their parents as sources of data. Relying on retrospective reports by adults can be problematic due to deterioration of memories, hindsight bias, and recall bias leading to less reliable reporting (Hardt & Rutter, 2004).

Sample size and effect size

Studies in this review varied in their sample size from 62 to 2353 MZ twin pairs. Turkheimer and Waldron's (2000) meta-analysis of studies of nonshared environment indicated that the proportion of total variance accounted for by differential parenting in adjustment, personality, and cognitive outcomes was .02. They highlighted the importance of large sample sizes in studies to be able to detect such small effects reliably. To detect an effect size of 2% with 80% power, studies would require a sample of at least 700 MZ twin pairs (Cohen, 1988). In this review, only 4 papers had a sample size of over 700 MZ twin pairs, and these were all samples taken from the TED study.

Even with this limitation, the studies in the review were able to find effects of this size or greater. Oliver, Pike, & Plomin (2008) suggest that modest effects are to be expected

when studying intra-familial environmental influences using the MZ twin differences method. Considering that potential confounders are automatically strictly controlled, the percentage of variance explained often does not exceed 5% (Guimond et al., 2012). Given the complex nature of human behaviour, it can be anticipated that effect sizes may be small when studying aspects of them (Ahadi & Diener, 1989).

Outcome measures

Cognition

Only one study examined cognitive outcomes (Asbury et al., 2006). It may be that negative, critical interactions work to withdraw the child's attention and effort, reducing their ability to learn. A lack of other associations of differential parenting with academic achievement may be indicative of nonshared environmental factors other than parenting. It may be that at age 7 children have more influences on their cognitive development from peers and school so parental influences reduce by this age.

Social Outcomes

The studies finding associations between parenting and social development outcomes may be explained in a number of ways. A social learning perspective suggests that parents model the recognition and response of different affects in their interactions with their children; and these learnt skills transfer to other interactions as children form social relationships. Attachment theory suggests that children develop working models of relationships in the context of their relationships with their parents, and secure attachments are linked to the development of social skills in children. A key component of a secure attachment relationship are aspects of parenting e.g. sensitivity. Freitag, Belsky, Grossmann, Grossmann, & Scheuerer-Engelisch (1996), for example, found early maternal sensitivity being associated with the ability to form friendships in older children.

Factors that may influence differential parenting

Measures of parenting

The studies in this review used a variety of measures to assess differing aspects of parenting, as well as using different measures for the same parenting variables. With some studies reporting composites of several aspects of interaction (e.g. positive parenting) and others reporting specific dimensions such as intrusiveness, it was not possible to identify any differences in the predictive value of the different components of involvement. Some similar behaviours may be defined in other studies as intrusiveness or it may be that more negative aspects of control such as being overly permissive or coercive are captured by low scores on dimensions such as responsiveness and acceptance. Nevertheless, most analyses of the three primary involvement components indicate that they are interrelated and comprise a single dimension suggesting that there is some validity in comparing studies which measure different aspects of the construct.

Extremes of discordance

Some studies in the review found greater associations between variables at the 10% most extreme behaviour-discordant and the 10% most extreme parenting-discordant MZ pairs, indicating the effect of parenting or behaviour being more important at extremes of both. Behavioural geneticists (e.g. Scarr & McCartney, 1983) have argued that more extreme environments or experiences are likely to exert influences which act as an “environmental main effect” (Burt et al., 2006). These findings lend some support to this hypothesis, as extreme differences in parenting or behaviour have been shown to have an effect on outcomes.

An emerging pattern of findings

Longitudinal data showed a number of child-driven effects on externalizing, internalizing and social outcomes; contrary to expectations. These are perhaps the most important findings in this review. Studies of nonshared environment have thus far generally examined correlations between differential parenting and child development outcomes within a *parent-driven* framework; with the assumption that differences in parenting have a *causal* role in child outcomes. However, the findings from the studies in this review indicate that this may be a false assumption. There appears to be mounting evidence for bidirectional influences, and effects which are specific to certain periods of development.

Transactional Model of Development

These findings may be conceptualised by the transactional model of development (Sameroff, 1975), which suggests a child's development is a product of continuous bidirectional interaction of the child and the environment (Hou et al., 2013). These transactions with the environment go beyond the relationship of parent and child: children and their parents are also situated in ecological systems that change and can be changed by those in the system (e.g. peer groups). Bronfenbrenner's (1979) bioecological theory supports this view, suggesting that interactions across multiple settings shape the development of child. (Burt et al., 2006), for example, suggest that differential environmental experiences (e.g. perinatal complications, peer relationships) may elicit differences among genetically identical children, which then elicit differential parental treatment. The findings from the reviewed studies fit with these models, and suggest that the examination of bidirectional relationships should be a focus of future studies of nonshared environmental factors.

Studies also demonstrated time-specific effects and effects that did not persist over time; suggesting there may be specific periods of time during development where particular effects occur. Cecil et al. (2012) demonstrated this effect: they found a significant bidirectional relationship between both negative parental feelings and self-control, and harsh parenting and self-control; but only from the ages of 4 to 7 years. Burt et al. (2006) present findings which indicate that for a general sample, most of the association between differential parent-child conflict and differences in adolescent outcomes is age specific and does not hold over time; due to the absence of cross-lagged associations in their data. However, this conflicts with Caspi et al.'s (2004) finding of maternal expressed emotion at 5 years predicting differences in child antisocial behaviour at 7 years. This may be explained due to the differing age ranges of the two studies (early childhood vs. adolescence), as parental influences may be stronger in early childhood than in adolescence. Burt et al. (2006) also found the parent-driven influence not being present from age 14 to age 17 years, and argue that this may be due to a weakening influence of the parent-child relationship in regards to adolescent behaviours at this age. Similarly, Spanos et al. (2010) show cross-lagged correlations which were significant during mid-adolescence (from 14 to 17 years) but were not significant from 11 to 14 years or from 11 to 17 years. This may indicate the influence of cumulative reciprocal effects of the parent-child relationship which increase over time so that effects are greatest at mid-adolescence.

The findings from these studies indicate there may be specific periods during development at which parental variables are particularly influential and these may differ across various developmental outcomes. Adolescent and adult twin studies to date have shown that although nonshared environmental processes are implicated in the

developmental outcomes of children, it is possible these processes change over the course of their development and lifespan (McCartney, Harris, & Bernieri, 1990).

Limitations

Some limitations of the studies in this review have already been discussed. Although interesting data can be gained from cross-sectional studies, they are limited in their scope as causal inferences cannot be drawn from them. The longitudinal studies in this review allowed for these inferences to be made.

The study of identical twin differences has a number of key advantages already noted, including controlling for genetic and shared environment influences. However, MZ twin studies may not generalise to other populations. It has been noted that the experience of parenting MZ twins may be different from raising single children from the first knowledge of pregnancy (Deater-Deckard et al., 2001). Lytton (1977) examined differences in the variance in parenting within a MZ and DZ twin study, with results suggesting that MZ twins are parented more similarly than are DZ twins. As found by Pike et al. (1996), parents of twins often feel they do not differentiate between their children in terms of parenting, but this is not found to be accurate by other raters. However, the MZ twin difference design remains a powerful tool for identifying potential sources of nonshared environment.

Most of the papers used samples of Western middle class populations. Although there was some variety with one “high risk” sample and three non-Western samples, the studies were somewhat limited in the diversity of the groups studied. This is particularly relevant as some studies found evidence for greater effects of parenting/behaviour in more extreme environments. There is also evidence that associations between parent-child relationship and developmental outcome may be stronger in families from poorer socioeconomic backgrounds (Seeley, Murray, & Cooper, 1996). In addition to this, the

studies in this review were unable to examine the effect of different cultural backgrounds on parenting and behaviour.

Clinical implications

Turkheimer & Waldron (2000) outlined the disappointing findings of 15 years of research into nonshared environmental factors which result in siblings growing up in different ways, suggesting that little progress had been made in uncovering these factors. Harris (1998) argued that “parents matter a lot less than you think” and peer influences outside of the family matter significantly more when considering sources of nonshared environment. The paper suggested research should shift towards nonshared peer influences as the primary focus. The findings of the studies in this review provide good cause for continued attention to be paid to parenting variables as a key source of influence on differential sibling outcomes. The findings of causal influences of aspects of parental behaviour on developmental outcomes also goes some way to allay the “gloomy prospect” put forward by Turkheimer (2000) that researchers may never identify the systematic sources of differences between siblings due to differences being created by random developmental processes.

A key target for research in to parenting variables has been to try and identify early antecedents to child development outcomes, often with the aim of developing interventions for families at risk of poor outcomes for children. The studies in this review have identified various parental behaviours such as negativity and harsh discipline as important. However, the findings do not reveal a simple linear process. It appears that a child’s development and socialization may be understood using more dynamic contextual model, that not only takes into account bidirectional influences between parents and children, but also views children as active participants in the developmental process who affect and shape their parents’ behaviour (Sameroff, 2010).

In this regard, the putative risk factors that are being revealed to have causal effects on developmental maladjustment may be a better target for treatment and intervention programmes. Findings demonstrating causal effects from an early age support an emphasis for interventions that ‘start at the beginning’, increasing the likelihood of producing favourable results as opposed to remedial interventions at a later stage (Tremblay, 2006). Evidence that parental behaviour and developmental outcomes can affect one another highlights the need for interventions that target both parents and children concurrently (Cecil et al., 2012).

Suggestions for further research

This review has shown there have been a large number of studies into parental variables and child outcomes. Future research could be focussed in a number of ways to help begin to find specific causal factors of particular behaviours and outcomes. As discussed previously, prospective longitudinal designs would allow the possibility of making causal inferences regarding factors of child outcomes. The studies in this review were all natural experimental designs. Caspi et al. (2004) argue that even passive longitudinal MZ twin designs cannot establish causality with certainty, and suggest that genetically informative intervention studies that seek to change parental behaviours may be most helpful in elucidating the causal status of parental behaviours in relation to children’s developmental outcomes. The findings demonstrating *influential periods* in a child’s development also point to the importance of measuring outcomes at various time points, to be able to measure the direction and magnitude of transient effects. The fitting of both synchronous and delayed effects models to these prospective longitudinal studies would enable ‘pure’ bidirectional effects to be elucidated between parenting and outcome variables (Yamagata et al., 2013). Pike et al. (1996) demonstrated the importance of multiple sources of data. Ratings for parental behaviours and outcomes should be taken

from children, parents, observers and others directly involved with the family. Teachers may be a good source of data: they are free of parental emotions towards the child, helping to test the direction of effect of factors such as parental expressed emotion. Similarly, observer ratings of parental behaviours or development outcomes would be free of bias found in parent ratings. Naturalistic observations would provide very useful data for future research.

Conclusion

This review aimed to examine the association between differential parenting and child outcomes. Results provided fair evidence for the influence of some observed parental behaviours on a range of outcomes, and also evidence for influence of developmental outcomes on the parenting received. Longitudinal studies also demonstrated potential shifts in parent-child relationships at different stages of childhood and adolescence. A picture emerged of the need for a more dynamic contextual model in understanding the transactional relationships which shape both parenting behaviours and children's developmental outcomes. Suggestions were made for further research in this area, in particular arranging studies which are longitudinal in design, with multiple sources of data and measures for synchronous and delayed effects.

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Part 2: Empirical Paper

Parenting, Attachment Security and Adjustment Outcomes: The Role of Nonshared Environment

Abstract

Aims Attachment security in children has been associated with a range of developmental and adjustment outcomes. The study aimed to test the role played by differential parenting in within-family differences in adolescent attachment, as well as the role of attachment in mediating the relationship between differential parenting and sibling differences in adjustment. We hypothesized that the twin that is relatively more secure will experience better quality of parenting than their co-twin; and that the twin with relatively better adjustment will be observed to experience better quality of parenting and attachment.

Methods A monozygotic twin difference design was used to observe a sample of 50 MZ twin pairs ($n = 100$) interacting with their mothers. Parenting was assessed by coding the videotaped interactions using established coding scales for parenting. Attachment security was assessed using the Child Attachment Interview, and adolescent adjustment was assessed using the self-report Youth's Inventory-IV.

Results Correlation analyses found none of the hypothesised associations between twin relative differences scores in parenting and attachment; attachment and adjustment; and parenting and adjustment.

Conclusions Possible explanations for our hypotheses not being met were considered: 1) our measures were not able to capture the hypothesised associations; 2) the hypothesised associations were not present; and 3) the study did not measure the relevant constructs of the nonshared environment we were examining. Limitations of the study were discussed, as well as implications of the study and recommendations for future research.

Introduction

Attachment

Attachment theory, as conceptualised by Bowlby (1969) and Ainsworth (1979) and colleagues, describes how early experiences with caregivers shape key aspects of the child's emotional development. In the parent-child relationship, attachment helps the parent provide a safe haven for the child and for the child to use the parent as a 'secure base' for exploration. Over time, these caregiving experiences are thought to be internalised by the infant as an attachment representation, or internal working model (IWM), of the self and other (Bowlby, 1969). The attachment system is refined over time and can be observed in terms of the 'security' of the relationship with caregivers. This security displays stability over time and is thought to be continually influential on behaviour and function throughout childhood, adolescence and adulthood (Hesse, 1999). A large number of studies have shown associations between attachment security and a range of outcomes, from quality of intimate-partner relationships to mental health status, as well as risk of emotional or behavioural disturbance (e.g. Bakermans-Kranenburg & van IJzendoorn, 2009). The study of attachment security and its causal influences is essential for the advancement of clinical interventions designed to affect these outcomes.

The strong hypothesis put forward by attachment theorists of the significant primary role played by environment on individual differences in attachment security has led to a conventional wisdom that environmental factors form the causal antecedents of attachment security. Quality of parenting is assumed to be the preeminent causal factor in the development of these differences, particularly the sensitivity and responsiveness of the parent to the attachment behaviour and cues of the child (Ainsworth, Bell, & Stayton, 1974).

Behavioural genetic studies

Quantitative genetic studies, such as twin and adoption studies, have emerged recently clearly demonstrating the importance of genetic effects on almost all measured psychological outcomes (Plomin, DeFries, Knopik, & Neiderhiser, 2013). Studies have also started to tease apart the genetic and environmental factors in attachment outcomes. Traditionally, socialization models of development led to studies assuming predictors of outcome (e.g. parenting) are shared environmental factors and only one child from each family has been studied. Thus, past studies have only analyzed parent-child associations between families, not within them, consequently missing important within-family differences (Plomin, 2011). An important contribution from genetic studies has been to demonstrate that where there is family resemblance in outcomes; genes typically play the largest role.

Two types of environmental variance, *shared* and *nonshared*, have been identified in quantitative genetic research (Rowe & Plomin, 1981). Shared environmental effects operate to make siblings similar in their outcomes, whereas nonshared environmental effects operate to make siblings different, i.e. environments influence on a child-by-child basis (Plomin & Daniels, 1987). Nonshared environmental processes might include experiencing different environments or sharing the same environment, but *experiencing* it in a different way; e.g. differential parental treatment of siblings or favouritism. Deater-Deckard (2000, p.469) argues that “*shared and nonshared environment should not be thought of as separate factors, but rather as distinct effects that can be derived from the same environmental factor*”. A second major contribution of behavioural genetics research has been to show that for the vast majority of outcomes, nonshared, not shared, environments are the predominant environmental influence.

Why are children in the same family so different from one another?

In 1987, Plomin and Daniels published a seminal article of this title outlining the evidence showing that the largest contributor to variance in children's social, emotional and cognitive outcomes is the nonshared environment rather than the shared environment. A more recent example of this was presented in a meta-analysis of genetic and environmental influences on antisocial behaviour showing nonshared environmental influence accounting for around 40% of the total phenotypic variance (Rhee & Waldman, 2002). Plomin and Daniels presented findings from behavioural genetic research that implicated parental influence on developmental outcomes on a child-specific level. The paper emphasised the importance of studying more than one child per family to elucidate the causes of differences within families. They presented three challenges to researchers to further understanding of the effects of nonshared environment: a) identify differential experiences between siblings; b) relate these differential experiences to differential sibling outcomes; and c) establish the causal associations between differential experiences and differential sibling outcomes (Plomin & Daniels, 1987). Table 2 shows the categories of nonshared environment that are presented in the paper, and all of these are predicted to make a contribution in differential outcomes (Plomin & Daniels, 1987). Since the publication of this article, research has focussed on the first two stages of this agenda. Studies have found significant differences in parental treatment between siblings within families (e.g. Feinberg & Hetherington, 2001) and also evidence for these differences predicting differential developmental outcomes (e.g. O'Connor Hetherington, Reiss, & Plomin, 1995). Far fewer studies have ventured to the third stage of the research agenda: establishing potential causal links between differential experiences and differential outcomes (Reiss, Neiderhiser, Hetherington, & Plomin, 2000).

Table 2: Categories of environmental influences that cause children in the same family to differ (adapted from Plomin & Daniels, 1987).

Categories	Examples
Error of measurement	Test-retest reliability
Nonshared environment	
Nonsystematic	Accidents, differential prenatal effects, illness, trauma
Systematic	
Family composition	Birth order, sex differences
Sibling interaction	Differential treatment or perceptions
Parent-child relations	Differential treatment or perceptions
Extrafamilial	Differential experiences with peers, friends, teachers, sports, other activities and interests, education, occupations, spouses, family life.

Turkheimer and Waldron (2000) presented a widely cited meta-analysis of 43 papers examining nonshared influences of differential outcomes in siblings published since the Plomin and Daniels (1987) article. The review concluded that research had been largely unfruitful and declared that “*measured nonshared environmental variables do not account for a substantial proportion of the nonshared variability*” (Turkheimer & Waldron, 2000, p.78). Plomin, Asbury, and Dunn (2001) however felt there was cause for optimism looking at the studies, citing that aggregate measures of differential environment accounted for 13% of the total variance. The authors argued that despite researchers having a key understanding of how genes work, there has been difficulty in identifying specific genes responsible for heritability due their apparent very small effect size (e.g. Plomin, DeFries, Craig & McGuffin, 2003). In this way, identifying specific nonshared environmental factors is likely to be at least as difficult (Asbury, Dunn, & Plomin, 2006).

Research progress in nonshared influence on attachment

When looking at infants, studies have consistently found evidence of environmental influence on attachment, e.g. Bokhorst et al. (2003). These studies have found little or no *genetic* influence and in remarkable contrast to other domains of development, strong *shared environmental* influence; which is very consistent with the predictions of attachment theory. However, Bokhorst et al. (2003) also demonstrated that organised and disorganised attachment classifications appear to be influenced differently in behavioural-genetic analysis. Attachment disorganisation appeared to have no similarity between twins (MZ or DZ), indicating influence only from nonshared environment and measurement error. This finding of *nonshared* environmental influence is not accounted for by attachment theory. When looking at twins within families, the overall security of twins was quite similar when examining the organised cases. In these cases, genetic factors appeared negligible, and the role of nonshared environment accounted for around half the variance. Regardless of genetic differences, the organized twins appeared relatively similar to each other in terms of attachment security; indicating the importance of environmental factors such as parental sensitivity in attachment security (Fearon et al., 2006). These studies indicate strongly the importance of understanding the precise environmental processes driving non-shared environmental aspects of attachment security and disorganization.

Parental sensitivity

Parental sensitivity has long been regarded as the crucial determinant of infant attachment security (Bowlby, 1969; Ainsworth, 1979). A meta-analysis by De Wolff and van IJzendoorn (1997) found sensitivity to indeed be significantly related to attachment security. In a similar way to shared environmental effects being restricted to organised

cases, sensitivity has been found to be associated with organised attachment patterns. Sensitivity has been found to be a reliable indicator of attachment security in infants, and studies have started to provide evidence that differences in sensitivity experienced between children can explain differences in attachment security in families (Roisman & Fraley, 2008)

Attachment in adolescence

As children grow from infancy to adolescence, there is a shift in the presentation and conceptualisation of attachment security. Attachment evolves from a construct that can be observed in aspects of infant behaviour, to one that may be assessed as a more generalised internal state of mind (Shmueli-Goetz, Target, Fonagy and Datta, 2008). As Bowlby (1969) described infant experiences of attachment becoming Internal Working Models over time, theorists have proposed exploring an individual's own account of their attachment experiences when examining their security beyond childhood years. In this regard, Main, Kaplan, and Cassidy (1985) described a "move to the level of representations" (p. 66) when describing the development of an interview-based method for assessing attachment security; the Adult Attachment Interview (AAI; George, Kaplan, & Main, 1985). The Child Attachment Interview (CAI; Target, Fonagy and Shmueli-Goetz, 2003) was developed using similar principles to the AAI to address the need for a measure of attachment in older children and adolescents. These interview-based methods are designed to access the representation of attachment an individual holds by exploring their attachment-related experiences and thus reflect their attachment organisation in the same way that their behavioural repertoires will do (Venta, Shmueli-Goetz, & Sharp, 2014).

In both the AAI and CAI, the *coherence* of the narrative with which they describe their attachment experience has been found to be the critical indicator of their attachment security (Shmueli-Goetz et al., 2008). This included aspects such as the consistency

between semantic and episodic memory; as well as the quality and quantity of their depictions of the availability and accessibility of their parents in times of need. For both measures, the score for *Overall Coherence* has been found to be the strongest predictor of infant security of attachment, leading to number of studies utilising this score as useful continuous measure of the attachment representation (Shmueli-Goetz et al., 2008).

Longitudinal studies have found evidence of limited continuity in attachment from infancy to later stages of life (e.g. Weinfield, Whaley, & Egeland, 2004). Furthermore, a recent study (Fearon, Shmueli-Goetz, Viding, Fonagy and Plomin, 2014) looking at genetic and environmental factors in adolescent attachment security in the *Twins Early Development Study* (TEDS; Trouton, Spinath, & Plomin, 2002) sample found a very different picture regarding the genetic and environmental influences on attachment in adolescence to that seen in infants: estimates of shared environment were effectively at zero, and there was strong evidence of genetic influence on attachment in adolescence, in contradiction to extensive infant studies. Critically in this context, a large portion, approximately 60% of the variance, was attributable to nonshared environment. However, the specific factors underlying this nonshared environment are as yet unknown.

Parenting and adolescent attachment

Although parental sensitivity is a key factor in childhood, few studies have elucidated what aspects of parental behaviour are influential in adolescence. It is likely that a positive, warm style of parenting continues to be associated with a secure attachment and a negative, angry style would be associated with insecure attachment. Scott, Briskman, Woolgar, Humayun, & O'Connor, (2011) measured parent-child relationship quality using factors such as warmth, communication, assertiveness, involvement, anger, and coerciveness to examine associations with attachment security in adolescents. They found evidence for significant associations between adolescent attachment representations and

quality of parenting. As a child develops into a more autonomous adolescent, other aspects of parenting may also take precedence in the security of attachment (Scott et al., 2011). For example, an adolescent's sense of security may be influenced by the knowledge that a parent is 'keeping them in mind' and is concerned for them when they are away from home. This dimension of *monitoring* in adolescence is related to the infant parenting quality of sensitive response, and its association with attachment security has started to gain support from studies (e.g., Kerns, Aspelmeier, Gentzler, & Grabill, 2001; Kerr & Stattin, 2000). Other aspects of parenting have also been explored in studies of adolescent attachment. Kobak, Cole, Ferenz-Gillies, Fleming, and Gamble (1993) observed parent-adolescent interactions and found attachment security to be related to less dyadic expression of anger and less dyadic avoidance of problem solving. Allen et al. (2003) found attachment security as measured by the Adult Attachment Interview (AAI: George et al., 1985) to have a modest correlation (.33) with dyadic relatedness and also a modest correlation with mother's attunement. However, it is still not yet clear whether within-family differences in such parental behaviours could account for the nonshared variance in attachment in adolescence.

Parenting and adjustment outcomes

The association between parenting and adjustment outcomes has also been of significant interest to researchers. Past studies have found a range of parental behaviours to also be associated with adolescent outcomes, including: parental warmth, acceptance, hostility, controlling behaviour, and negativity (Asbury, Dunn, Pike, & Plomin, 2003; Mullineaux, Deater-Deckard, Petrill, & Thompson, 2009). Directly relevant to questions regarding the role of parenting in the non-shared environment in adolescence, Pike and Plomin (1996) found a correlation between relative differences in maternal negativity (between one twin and the other) and relative differences in depression was .33 in an MZ

twin sample from the *Nonshared Environment and Adolescent Development Project* (see Reiss et al., 2000). This correlation represents an effect independent of genetics, demonstrating maternal negativity as a nonshared environmental aspect in relation to children's adjustment. Given the importance of attachment as a factor influencing children's mental health and wellbeing, a further crucial question is whether within-family differences in attachment, and the parenting features associated with it, can explain within-family differences in outcome.

Attachment and adjustment

Equally important as understanding the parental antecedents of adolescent attachment is the question of the role these factors may have in predicting adjustment outcomes for adolescents. Studies have shown attachment security at adolescence appears to be a strong predictor of behavioural adjustment and risk of psychopathology (Kobak, Zajac, & Smith, 2009; Rosenstein & Horowitz, 1996), hence it is a critical stage to study in regards to clinical interventions and prevention programs. Alongside exploring adjustment outcomes, Scott et al. (2011) also studied associations between adolescent attachment and their measured parenting variables. They found evidence for adolescent attachment representations predicting behavioural outcomes independently of measures of quality of parenting. Allen et al. (2002) found a strong correlation ($r = .46$) between AAI security and social skills in adolescents, with secure individuals also having better outcomes 2 years later. Research thus far has demonstrated that attachment security can predict adjustment outcomes in adolescents, but further research is needed to clarify these links.

Controlling for genetic effects

The behaviour genetic studies mentioned thus far have almost entirely consisted of multivariate genetic analyses. A major consideration in these studies is that of 'third factors', which may mediate relationships between parenting and children's outcomes.

Genes maybe a significant ‘third factor’ in the study of siblings; as siblings may differ due to nonshared environmental factors, but also for genetic reasons as they share 50% of their genes. Genetic effects have also been established beyond just heritable traits; studies have found measures of environment show significant genetic influence when investigated as dependent variables in a large number of twin and adoption studies (Plomin, 2011). A review of 55 studies found an average heritability of around 25% for familial and extra-familial measures of environment (Kendler & Baker, 2007), providing evidence for the so-called issue of the “nature of nurture” (Plomin & Bergeman, 1991). These gene-environment correlations occur when exposure to environments are influenced by genetic propensities; and so significant life events and stressors are not experienced independently of the person – they may contribute to their experiences to some degree (Plomin, 2011). In this regard, when studying factors of the nonshared environment (i.e., differences between siblings), it is essential to control for genetic differences between siblings, and genetically-driven correlations between measures of the environment and measures of children’s outcomes. An established study design that is capable of this is the monozygotic twin difference design.

Monozygotic twin differences design

A direct measure of nonshared environment can be made by studying differences within pairs of monozygotic twins as genes are controlled for by the nature of the sample. Pike, Reiss, Hetherington, and Plomin (1996) introduced this design as an “unambiguous tool” for examining the nonshared environment: as MZ twins brought up in the same family are genetically identical, their differences in experience and in outcome can only be due to nonshared environment and error of measurement (Plomin, 2011). Furthermore, nonshared environmental effects linking developmental predictors (e.g. parenting) to outcome can be powerfully demonstrated if MZ twin differences in experience correlate

with differences in their outcomes. This method rules out the two possibilities: a) that a genetic influence explains both the variance in parenting and the outcome of the child and b) that genetically influenced differences between children evoke differential parenting (Caspi et al., 2004).

Important findings have emerged since this method was introduced, with studies finding associations between differential parenting and adjustment outcomes (e.g. Asbury, et al., 2003; Burt, McGue, Iacono, & Krueger, 2006; Mullineaux et al., 2009). Significant associations have been found between differential negative and hostile parenting and behavioural outcomes in childhood (Asbury et al., 2003) and in adolescence (Pike et al., 1996); as well as longitudinal studies showing both differential maternal warmth and negativity at age 5 being associated with behavioural problems at age 7 (Caspi et al., 2004).

The current study

This study sought to explore potential systematic sources of nonshared environment (see Table 2) in adolescent attachment security and adjustment. In particular, the study aimed to test the role played by differential parenting in within-family differences in adolescent attachment. In considering the conceptual shifts of attachment security from infancy to adolescence, this study would be able to explore how differential parenting may associate with elicited representations of attachments from adolescents. The current study represents the first study to use the MZ-twin differences design to investigate the relationship between parenting quality and adolescent attachment. A second aim of the study was to test the role of attachment in mediating the relationship between differential parenting and sibling differences in adjustment. We used direct observations of parent-adolescent interactions for each of two twins separately to measure parenting quality, and well-validated measures of attachment security and adjustment outcome.

Aims

In light of the findings from previous research on parenting, we hypothesized that the twin that is relatively more secure will be observed to experience a better quality of parenting (higher warmth, responsiveness, mutuality, less anger and conflict) than their co-twin who is less secure. It was also hypothesized that the twin with relatively better adjustment will be observed to experience better quality of parenting and attachment than their more poorly adjusted co-twin. The final aim of the study is to examine the joint (i.e. mediated) and independent effects of attachment and parenting on the adjustment outcomes of the twins.

Method

Participants

Participants were drawn from a large twin study conducted in the UK. The *Twins Early Development Study* (TEDS) is a large longitudinal cohort of UK twins studied intensely since infancy (Trouton et al., 2002). All twins born in England and Wales during 1994, 1995 and 1996 were identified through birth records, and their parents were invited to participate in the study. A total of 16,810 parents of twins responded to register their interest. Assessments were made at various stages up to adolescence. At the first assessment, 16,286 families were sent booklets to complete. Of these families, 13,601 (84%) provided data at the first assessment. Sample sizes in later cohorts varied between 6900 to 5900 twin pairs. Throughout the course of the study, the families remained reasonably representative of the UK population when compared to census data. For example, 92% of the mothers in the TEDS sample were white, and 92% of UK mothers are white. 32% of UK mothers have A-levels, and 34% of the TEDS mothers had A-levels. Mothers in the TEDS sample were somewhat less likely to be working (41%) than the UK

population (49%). Twin zygosity was assessed through a parent questionnaire of physical similarity. This method has been shown to be over 95% accurate when compared against DNA testing (Price et al., 2000). Questionable cases were further assessed through DNA analysis (Kovas, Haworth, Dale, & Plomin, 2007).

Current study sample: Participants were 50 MZ twin pairs selected at random from the main sample. There were 23 male and 27 female twin pairs. Mean age at assessment was 14.9 years (range 13.8 – 15.6 years). The majority of the families were white (82%). The median household income was £30,000-£50,000, with 74% of fathers and 64% of mothers in full or part time employment. 38% of mothers and 34% of fathers were educated to a degree level or higher. The study sample was less likely to be white, more likely to be employed, had a higher level of education and higher household income in comparison to national average data obtained from the Office of National Statistics. Further demographic information is presented in Table 4 in the Results section. The twins were assessed alongside their primary caregiver (their mother in almost all cases).

Researchers

The coding for observed parenting variables was carried out in conjunction with another researcher, as part of a joint project. The concurrent study examined these variables in a larger mixed sample of MZ and DZ twins (see Glazebrook, 2015).

Measures

Adolescent attachment: The *Child Attachment Interview* (CAI: Target et al., 2003) is a semi-structured interview designed to access the adolescent's mental representations of their parental attachment figures, and thereby their attachment security. The interview was originally intended for use with 8- to 12-year-olds, but has been employed in studies with adolescents up to the age of 16 (Venta et al., 2014). It is conceptually based on the AAI

(George et al., 1985); a well-established and validated measure, with some important adaptations. The approach is generally more flexible, developmentally appropriate and shorter in duration to assist children with its demands without compromising validity (Venta et al., 2014). The focus of the interview is on recent events or episodes as opposed to retrospective accounts. The interview protocol consists of 17 questions exploring the representations of the current attachment relationships with their parental attachment figures. Participants are asked to describe relationship qualities, what happens when the parent gets angry, when the adolescent is ill, when hurt and when upset. These more *negative* events are explored as it is more likely that adolescents will call upon their primary attachment figure as a secure base at those times. Adolescents' narratives are assessed in terms of the coherence of their descriptions and their capacity to reflect upon the impact of their experiences. The 30 to 60 minute interview is videotaped and transcribed for analysis. It is then coded by individuals who have completed training and established reliability with the measure's authors, taking into account the content of the narrative but also nonverbal behaviour of the respondent. The coder scores from 1 to 9 on eight subscales: narrative coherence, emotional openness, emotional balance, use of examples, resolution of conflict, idealization of the parent, dismissal of the parent, and anger toward the parent. The coding yields four attachment classifications: Secure, Insecure-Dismissing, Insecure-Preoccupied and Disorganised/Disoriented.

The CAI has shown strong psychometric properties, with excellent test-retest reliability over a three month and one year period (Shmueli-Goetz et al., 2008). Both the attachment classifications and overall coherence have shown good test-retest reliability and criterion validity, strongly correlating with indices of psychological adjustment and differentiating normal from clinical samples with effect sizes in the range $d = .60 - .70$ (Scott et al., 2011). Shmueli-Goetz et al. (2008) found that security and coherence as measured by the CAI are not correlated with verbal IQ, expressive language skills, age, socioeconomic

status or ethnicity; demonstrating good discriminant validity for the measure. Further to this, the CAI was strongly predicted by maternal security of attachment using the AAI in two independent studies (Jacobson & Yumoto, 2009; Shmueli-Goetz et al., 2008). For the TED study, coders were trained in the interviewing and coding of CAIs by one of the authors of the measure. The coders for the study achieved >80% agreement for attachment classifications from a standard reliability set. A further 32 cases were randomly selected to check reliability. The inter-rater reliability (intraclass correlation) for Coherence was .72.

Studies of attachment have often used the *narrative coherence* score as a continuous measure of attachment security (e.g. Stern, Borelli, & Smiley, 2015). The present study also uses the score for coherence as a measure of security of attachment.

Parenting: Observational data is widely considered the gold standard for assessing aspects of parenting and the relationship quality between parent and child (Scott et al., 2011). The 'hot topics' paradigm from Hetherington et al. (1999) was used to examine the parent-child relationship. This task is completed with the primary caregiver and one twin, and repeated separately for the other twin. A researcher briefs the adolescent regarding the task, explaining that a discussion between themselves and their parent would be videotaped. The topic of the discussion will be on two or more sources of moderate to intense disagreement between the adolescent and their parent. These topics are selected by the adolescent with the help of a list provided of common sources of disagreement; e.g. friends, grades/schoolwork, chores, personal appearance, use of computer, etc (see Appendix for full list). Once the topics are selected, the adolescent and parent are placed in a room and informed that they will be videotaped for eight minutes discussing the topics of disagreement. The adolescent is provided with a cue card which instructs them to: describe the disagreement; explain both adolescent's and parent's sides of the disagreement; and to try to find a solution to the disagreement with their parent (see Appendix for full

instructions). The use of topics that cause genuine disagreement, rather than hypothetical problems, for the parent and child is designed to encourage discussion typical of the dyad's interaction style with each other. By using the dyad's own problems and with the observers not present in the discussion, it is hoped this will simulate an argument as it would naturally unfold in the home (Hetherington et al., 1999). The videotaped interactions are then coded using the *Family Interaction Coding System* from an earlier study (Hetherington & Clingempeel, 1992). Each participant's behaviour is coded using 5-point global scales, providing the parent and adolescent each a score for: *warmth/support*, *anger/rejection*, *coercion*, *involvement*, *communication*, *authority/control*, *assertiveness*, *self-disclosure*, *transactional conflict*, *problem solving outcome*, *positive mood*, and *depressed mood*. Each of these scales were scored from 1 to 5, with higher scores representing a higher quality of parenting.

Adaptation of scales. The coders for this study were both extensively trained and communicated with the authors of the Scott et al. (2011) paper regarding adjustments to the coding. Through this initial exploratory stage of training, it was decided that a number of adaptations would be made to the scales based on findings from the literature and examination of a significant number of video recordings of interactions from the larger TEDS sample. For example, interactions were observed where the parent appeared actively supportive of their child, but did not demonstrate overt warmth. The scale for *warmth/support* was thus separated into two individual scales for warmth and support, as it was felt that the two were separate constructs which may have an independent bearing on the parent-child interaction. Warmth is likely more related to parental temperament and therefore possibly less likely to be linked to attachment security; and there have been significant cultural variation observed in this construct (e.g. Hofferth, 2003). Self-disclosure was felt to be unrelated to the concept of a parent being a 'secure base' for a child, and so it was removed. Authority/control was removed due to the scale confounding authoritative

and authoritarian parenting, which are thought to have quite opposed effects on children's development (e.g. Neal & Frick-Horbury, 2001). The problem solving scale was adjusted to reflect a scale more related to problem solving *process* rather than outcome. This was as a result of viewing some interactions which showed dyads coming to a 'solution' which one or both parties acquiesced or appeared disingenuous regarding. It was felt this did not adequately demonstrate problem solving skills, and so the scale was adjusted to account for effort, investment and skill in finding a solution to the disagreement.

Coding of Attachment-Related Parenting. As per Scott et al. (2011), the scales for *mutuality* and *sensitive responding* from the Coding of Attachment-Related Parenting (CARP: Matias, Scott, & O'Connor, 2006) were included in the coding scheme for the videotaped interactions. These scales were originally designed for parent-infant non-verbal play interactions, and the original coding scheme reflected this. The scales were adjusted in view of the observations being of a verbal disagreement between a parent and adolescent. Each of these scales were scored from 1 to 7, with higher scores representing a higher quality of interaction.

Openness and Underlying Tension. In a sample of pilot cases, coders observed qualitative differences in the parenting of twins in the videotaped interactions examined during training. These qualitative differences appeared to concurrently relate to differences in attachment security between the twins. The coders attempted to conceptualise the differences in observed parenting that were felt to be inadequately captured by the available coding schemes, and thus two new scales were created and added to the coding schedule: *openness* and *underlying tension*. 'Openness' related to the degree to which a genuine, open and comfortable interaction is demonstrated in the dyad. This was scored by raters for the sense of ease towards the other, as well as willingness to engage openly; and could be seen broadly as 'how easily the two could sit and have a conversation with each

other’ (see Appendix for full scale guidance). ‘Underlying tension’ referred to situations where the discussion between parent and adolescent seemed strained and both sides appear reluctant to change their own ideas or to compromise. This scale coded for more subtle interactions and tension rather than overt conflicts, which could be broadly conceptualised as a ‘battle of wills’ between the two. Coders took into account behaviours such as resistance, disengagement, and falseness when scoring this scale (see Appendix for full scale guidance). Each of these scales were scored from 1 to 7, with higher scores representing a higher quality of interaction.

Both coders trained until they reached a criterion level of 70% agreement with each other. 10% of all the subsequent codings were rated by both coders for reliability purposes. One scale, *parent communication*, dropped to an intraclass correlation coefficient (ICC) of .16. This scale was removed from subsequent analyses. The mean ICC for all the included scales was .75.

Table 3: Intraclass correlation coefficients for scale items.

Measure	Parent Subscale	ICC (n= 30)
	Anger	.87
	Warmth	.78
	Support	.75
	Coercion	.58
<i>Family Interaction Coding</i>	Assertiveness	.68
<i>System</i> (Hetherington & Clingempeel, 1992)	Involvement*	.52
	Parent-child transactional conflict	.86
	Communication*	.16
	Depressed mood*	.84
	Positive mood	.72
	Problem-solving	.77
<i>Coding of Attachment-Related Parenting</i> (Matias et al., 2006)	Sensitive responding	.70
	Parent-child mutuality	.81
<i>Newly created scales</i>	Openness	.74
	Parent-child underlying tension	.79

Note: *subscale not included in later analysis

A factor analysis was carried out on these subscales in the concurrent study with a mixed sample of MZ and DZ twins (Glazebrook, 2015). Communication was not included in the factor analysis because of the low inter-rater reliability. After analysing data for both twins, the analysis indicated a one factor model. However, depression and involvement had low loadings on the factor and so these variables were dropped. Therefore the *quality of parenting* variable (a latent variable) for each twin was created by taking the sum of the ratings for anger, warmth, support, coercion, assertiveness, transactional conflict, positive mood, problem-solving, sensitivity, mutuality, openness and underlying tension (negative variables were recoded). These identified subscales were later used in the data analysis.

Adolescent adjustment: The *Youth's Inventory-4* (YI-4: Gadow & Sprafkin, 1999) measure was used to assess adolescent internalizing and externalizing outcomes. The YI-4 was designed to evaluate emotional and behavioural disorder symptoms in youths between 12 and 18 years old, as per the Diagnostic and Statistical Manual of mental disorders (DSM-IV: American Psychiatric Association, 1994). The measure is a self-report rating scale questionnaire containing 128 items that correspond to the behavioural, cognitive, and affective symptoms of DSM-IV disorders. Symptom categories include internalizing and externalizing symptoms: attention-deficit/hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), conduct disorder (CD), major depressive disorder (MDD), dysthymic disorder, generalized anxiety disorder (GAD), and separation anxiety disorder (SAD), schizophrenia, Bipolar Disorder, Eating Problems, and Substance Use (Gadow et al., 2002). YI-4 also contains rating items for Somatization Disorder and Schizoid Personality Disorder, as well as an Inconsistency Index to assess inconsistent responses to similar items (which is considered to be a characteristic of unmotivated or noncompliant responding) (Gadow et al., 2002).

The YI-4 has shown good psychometric properties in a community sample; with satisfactory internal consistency (α values = .66-.87), good test-retest reliability over a two week period (r values = 0.54–0.92) and convergent and divergent validity with other self-report measures (Gadow et al., 2002). The YI-4 ratings have also shown good discriminant validity by differentiating children with and without diagnosed ADHD, CD, GAD, MDD or substance use. Gadow et al. (2002) also found good discriminant validity for the measure, demonstrating that YI-4 symptom severity scores are not correlated with IQ, socioeconomic status or gender (except Eating Problems, where females received higher scores).

For the purposes of this study, the total score for adjustment was used to measure adjustment outcome, as well as the score for total internalizing disorders and total externalizing disorders.

Child and family characteristics and covariates: Demographic data collected from the TEDS sample was used to assess details about age, gender, family income, parental education and occupation. This was collected at the first point of contact from the parents of the TEDS twins using booklets.

Ethical considerations

Ethical approval for the *Twin Early Development Study* was provided by the University of Reading Research Ethics Committee and written informed consent was obtained from all participants.

Sample size

A power analysis was carried out based on twin pairs. In order to have 80% power to detect an effect size equivalent to a correlation of 0.30 (the estimate from Pike & Plomin, 1996) in a regression with 3 covariates, at $\alpha = 0.05$, a sample size of 64 twin pairs would be required. In light of the fact that this may represent an overestimate of the effect size we

also calculated power for smaller effects. With a slightly lower estimate of the effect size, 0.25, 94 twin pairs would be required. The researchers were able to code 50 MZ twin pairs.

Research design

The design of this study was a *monozygotic twin difference* design, looking at the correlation within MZ twin pairs of parent-child relationship quality and attachment security as measured by the *coherence* scale of the CAI. This design uses relative difference scores to observe the association between twin differences in experiences and twin differences in outcomes.

Data analysis

In this study, the relative difference method calculates the *relative difference* between twins for the parental variables (Twin 1 environment score – Twin 2 environment score) and correlates that with relative differences of the twins for their scores on coherence. Within each twin pair, the twins were assigned randomly as Twin 1 or Twin 2. A relative difference score was then calculated by subtracting the score for Twin 2 on each parenting subscale from the score for Twin 1 on each parenting subscale. In addition to these within-family effects which are the main focus of the study, analyses were also conducted on family-level associations. This was done by computing the twin averages for the relevant variables. For example, in order to test whether family level covariates were related to parenting quality, these covariates were correlated with the average of both twins' parenting scores. Similarly, to test whether overall, those families where there was higher parenting quality tended to have more secure adolescents, the average of the parenting quality scores for each twin were correlated with the averages of their attachment coherence scores. It is important to note that family-level variables (e.g. income) cannot explain within-family differences (i.e. which twin has lower security or experiences lower parenting quality), although they may relate to the overall degree of

within-family differences (e.g. bigger differences in parenting quality in general among families in low-income circumstances). Thus, we also looked at associations with covariates and *absolute differences* in parenting and attachment.

Descriptive data is first shown which illustrates the range of scores and demographic characteristics of the sample. After this, potential covariates are identified for the next stage of analysis. The main analysis of the data will correlate difference scores for coherence from the CAI with difference scores for parental variables from the parent-child observational data. Next, difference scores for coherence will be correlated with difference scores for adolescent behavioural adjustment. Difference scores for parental variables will also be correlated with difference scores for behavioural adjustment. Regression analysis will be used to control for variables such as gender, age, socioeconomic status, etc.

Pearson correlations were used to assess the relation between continuous variables. We adopted Cohen's (2013) criteria and refer to the magnitude of reported correlations around 0.10, 0.30, and 0.50 as indicative of small, medium/moderate, and large/strong associations, respectively. Analysis of variance (ANOVA) and *t*-tests were used for group comparisons involving continuous variables. To identify the source of significant interaction effects (ANOVAs), subsequent simple effects tests were conducted. Only statistically significant ($p < .05$) group differences are noted.

Results

The results of the study are presented in four parts. First, descriptive statistics are presented of the study sample, attachment data, parenting data and adjustment outcomes. Secondly, statistical tests are presented examining whether attachment (as measured by coherence) and parenting variables are associated with any demographic variables. Thirdly,

associations between coherence and parenting between and within twin pairs are examined. Fourthly, the main analysis is presented associating differences *between* MZ twins in parenting variables and differences between MZ twins in coherence; as well as associations between differences in parenting and differences in adjustment, and differences in coherence and differences in adjustment.

Descriptive data for sample

Table 4 presents the demographic characteristics of the sample. A significant proportion (11%) of parental education data was missing for girls, possibly leading to a skewed representation. All other data was >90% complete.

Table 4: Participant characteristics

	Boys	Girls
<i>Demographics</i>	<i>n</i> = 46	<i>n</i> =54
Age	14.8 (0.28)	14.9 (0.24)
Median family income	£30,000-£50,00	£30,000-£50,00
Maternal education degree or above	52.2%	29.2%*
Paternal education degree or above	47.8%	25.0%*
Maternal full/part-time employed	69.5%	59.2%
Paternal full/part-time employed	87.0%	70.4%

Notes: Figures are mean (standard deviation) or %. *11% of parental education data for girls was missing

Table 5 presents key descriptive findings for the sample. The descriptive data indicates that girls are, on average, subjected to a higher degree of parenting on each assessed variable, including both positive and negative aspects (e.g. coercion and transactional conflict). Statistical tests of these differences are presented in the next section.

Table 5: Sample mean and standard deviations for outcome scores presented by gender.

	Boys		Girls		Average	Average
	Twin 1	Twin 2	Twin 1	Twin 2	boys	girls
	<i>n</i> = 23	<i>n</i> = 23	<i>n</i> = 27	<i>n</i> = 27	<i>n</i> = 46	<i>n</i> =54
<i>Attachment</i>						
Coherence	4.5 (1.82)	4.9 (2.22)	5.5 (1.65)	5.6 (1.74)	4.7 (1.72)	5.6 (1.31)
<i>Parenting</i>						
Overall parenting	49.9 (13.93)	52.8 (11.22)	56.5 (9.99)	55.4 (9.60)	51.3 (11.04)	55.9 (8.42)
Anger	4.0 (1.24)	4.3 (1.11)	4.3 (0.95)	4.4 (0.84)	4.2 (1.17)	4.3 (0.89)
Warmth	3.3 (1.43)	3.8 (1.15)	3.9 (0.96)	3.7 (0.83)	3.6 (1.31)	3.8 (0.90)
Support	3.6 (1.20)	3.9 (0.79)	4.1 (1.03)	3.9 (0.95)	3.7 (1.02)	4.0 (0.99)
Coercion	4.0 (1.28)	4.3 (1.11)	4.5 (0.94)	4.4 (0.97)	4.2 (1.19)	4.5 (0.95)
Assertiveness	4.0 (1.13)	4.1 (0.76)	4.3 (0.71)	4.3 (0.83)	4.1 (0.95)	4.3 (0.77)
Transactional conflict	4.1 (1.01)	4.1 (1.01)	4.4 (0.97)	4.3 (0.96)	4.1 (1.00)	4.4 (0.96)
Positive mood	3.4 (1.27)	3.6 (0.98)	4.1 (0.78)	3.9 (0.78)	3.5 (1.13)	4.0 (0.78)
Problem-solving	3.8 (0.98)	3.9 (0.97)	4.1 (0.85)	4.1 (0.91)	3.8 (0.97)	4.1 (0.87)
Sensitive responding	4.7 (1.70)	5.0 (1.46)	5.5 (1.25)	5.2 (1.15)	4.8 (1.57)	5.4 (1.20)
Mutuality	4.7 (1.53)	4.8 (1.48)	5.4 (1.21)	5.3 (1.17)	4.7 (1.49)	5.3 (1.18)
Openness	5.0 (1.61)	5.6 (1.27)	5.9 (1.04)	5.7 (1.10)	5.3 (1.46)	5.8 (1.07)
Underlying tension	5.3 (1.94)	5.3 (1.58)	6.0 (1.57)	6.1 (1.19)	5.3 (1.75)	6.1 (1.38)
<i>Adjustment</i>						
Overall	30.8 (8.31)	34.3 (9.65)	28.4 (13.48)	30.7 (13.45)	32.6 (7.29)	29.2 (11.26)
Internalizing	32.9 (9.53)	37.0 (10.32)	32.0 (14.14)	35.8 (16.02)	35.0 (8.23)	33.9 (13.67)
Externalizing	28.8 (9.12)	31.6 (10.99)	24.8 (14.67)	23.3 (9.93)	30.2 (8.03)	23.7 (10.31)

Notes: Figures are mean (standard deviation)

Analysis of associations with demographic variables

Table 6 presents the results of statistical testing completed to examine associations between demographic variables (e.g. age, gender) and mean scores between twins for coherence and parenting, as well as absolute differences between twins for these scores. Only gender was found to have a significant association with mean coherence ($F(1,48) = 4.13, p = .048$), indicating that female twin pairs tended to have higher scores on

coherence, and therefore greater attachment security. All other results were not significant, indicating that no other demographic variable had an influence on the mean coherence and parenting scores of the twin pairs, i.e. there was no family level effect. No demographic variables were found to be significantly associated with absolute differences in coherence and parenting, demonstrating that these variables did not have an influence in the degree of difference *within* twin pairs.

Table 6: Analysis of potential covariates.

Covariates	Mean coherence	Mean parenting	Absolute differences in coherence	Absolute differences in parenting
Age	$r(50) = -.17, p = .23$	$r(50) = .03, p = .83$	$r(50) = .22, p = .13$	$r(50) = .05, p = .73$
Gender	$F(1,48) = 4.13, p = .048^*$	$F(1,48) = 2.79, p = .10$	$F(1,48) = 0.32, p = .58$	$F(1,48) = 1.62, p = .21$
Family income	$F(4,43) = 1.15, p = .35$	$F(4,43) = 2.16, p = .09$	$F(4,43) = 1.15, p = .35$	$F(4,43) = 0.12, p = .98$
Paternal education	$F(3,42) = 1.24, p = .31$	$F(2,43) = 1.12, p = .34$	$F(2,43) = 0.22, p = .80$	$F(2,43) = 0.49, p = .61$
Maternal education	$F(2,44) = 2.37, p = .10$	$F(2,44) = 0.08, p = .92$	$F(2,44) = 0.89, p = .42$	$F(2,44) = 0.05, p = .95$
Paternal occupation	$F(1,48) = 0.44, p = .51$	$F(3,41) = 0.44, p = .73$	$F(1,48) = 0.99, p = .33$	$F(1,48) = 1.36, p = .25$
Maternal occupation	$F(3,44) = 0.38, p = .77$	$F(3,44) = 2.14, p = .11$	$F(2,44) = 0.77, p = .52$	$F(3,44) = 1.84, p = .15$

Notes: *Correlation is significant at the 0.05 level (2-tailed)

Is Quality of Parenting associated with Coherence?

The Overall Parenting score between Twin 1 and Twin 2 was found to have a significant strong correlation ($r(50) = .52, p < .001$), indicating that the MZ twins in this sample were parented fairly similarly, as can be expected. However, the lack of a perfect correlation for parenting between monozygotic twins demonstrated that a large part of the variance could be attributed to nonshared environmental factors. Coherence within twin

pairs was also found to have a moderate significant correlation ($r(50) = .36, p = .011$), similarly demonstrating that twins were similar in their attachment security. Despite these similarities, a large part of the variance is still accounted for by the nonshared environment. Before testing within-twin effects, we examined the overall family level association between coherence and parenting. The mean coherence score and mean parenting score between twin pairs were found to correlate significantly ($r(50) = .28, p = .048$).

Can differences in Parenting account for differences in Coherence between MZ twins from the same family?

For the main analysis, we analyzed MZ twin relative difference scores on all measures of the parenting and attachment outcome. Table 7 presents the correlations between the variables.

Table 7: Correlations Between MZ-twin Differences in Parenting Variables and MZ-twin differences in Coherence.

MZ-twin differences in Parenting variables		
	Coherence (r)	p
Anger	-.02	.90
Warmth	.18	.22
Support	.08	.61
Coercion	.23	.11
Assertiveness	.11	.46
Parent-Child Transactional Conflict	-.20	.16
Positive Mood	.11	.44
Problem Solving	-.23	.11
Sensitive Responding	.13	.37
Parent-Child Mutuality	-.03	.82
Openness	.01	.93
Parent-Child Underlying Tension	.06	.69

Notes: $n = 50$ pairs, p -values 2-tailed.

As can be seen in Table 7, there were no associations between relative differences in parenting variables and relative differences in coherence within twin pairs. This indicated

that although at a family level, higher quality of parenting was found to be associated with greater attachment security, relative differences in parenting could not account for relative differences in attachment security between twins in the same family.

Adjustment Outcomes

Table 8 presents family-level associations between adjustment outcomes and parenting and coherence scores. The mean adjustment score for twin pairs was not found to be significantly associated with mean coherence ($r(50) = -.01, p = .92$), indicating that overall greater attachment security does not account for greater levels of adjustment. Mean adjustment was also not associated with mean parenting ($r(50) = -.18, p = .20$), similarly indicating that overall higher quality of parenting does not account for greater levels of adjustment. Associations for the two components of overall adjustment, internalizing and externalizing outcomes were explored. A moderate correlation was found between overall parenting and externalizing outcomes ($r(50) = -.29, p = .04$). This finding demonstrated family-level effect: at the family-level, overall higher quality of parenting is associated with lower levels of externalizing behaviour.

Table 8: Correlations between mean twin scores in Adjustment, Overall Parenting and Coherence.

	Overall			
	Adjustment (r)	Externalising (r)	Internalising (r)	Coherence (r)
Externalizing	.86**			
Internalizing	.93**	.63**		
Coherence	-.01	-.06	.02	
Parenting	-.18	-.29*	-.07	.28*

Notes: $n = 50$ pairs ** Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

These associations were examined further by analyzing MZ twin relative difference scores on adjustment outcomes and MZ twin relative difference scores on overall parenting and attachment outcome. Table 9 presents the correlations between the variables. No significant associations were found for relative differences in overall parenting and relative differences in adjustment within twin pairs. This indicated that relative differences in parenting could not account for relative differences in adjustment outcomes between twins in the same family. Similarly, relative differences in coherence were not associated with relative differences in adjustment within twin pairs, indicating differences in coherence could not account for adjustment outcomes between twins in the same family.

Table 9: Associations Between MZ-twin Differences in Adjustment and MZ-twin differences in Coherence and MZ-twin differences in Overall Parenting.

MZ-twin differences in Adjustment	MZ-twin differences in Coherence and Overall Parenting	
	Coherence (<i>r</i>)	Overall parenting (<i>r</i>)
Overall Adjustment	-.03	.04
Internalizing	-.05	.15
Externalizing	.03	.02

Notes: *n* = 50 pairs

Discussion

The aim of this study was to explore sources of nonshared environment in adolescent attachment security and adjustment. Specifically, the study aimed to examine MZ twin differences in adolescent attachment and to attempt to account for this nonshared environmental variance by measuring relative MZ twin differences in parental variables. A secondary aim of the study was to test the role of attachment in mediating the relationship between differential parenting and sibling differences in adjustment. Direct observations of

parent-adolescent interactions were used to measure parenting quality, and well-validated measures were used for attachment security and adjustment outcome.

The main hypotheses of the study were not supported. None of the hypothesised associations were found between relative differences in twin scores in attachment security and parenting variables; attachment and adjustment; and parenting and adjustment. As no associations were found in the relative difference scores, the role of attachment in mediating the relationship between differential parenting and adjustment was not tested. The findings of the study are discussed in light of the study hypotheses and current literature.

Analysis of covariates

Family level covariates were correlated with the average of both twins' parenting scores to test whether they were related to parenting quality. Only gender was found to have a significant association with mean coherence ($F(1,48) = 4.13, p = .048$), indicating that the female twin pairs tended to be more securely attached than the male twin pairs. All other associations were not significant, indicating that parenting quality and attachment security of the twin pairs was not influenced by demographic variables, i.e. there was no family level effect. Our results demonstrated that family-level covariates (e.g. income) are largely unrelated to family level associations with coherence and parenting.

Associations between Quality of Parenting and Coherence

To test whether those families where there was higher parenting quality tended to have more secure adolescents, the average of the parenting quality scores for each twin were correlated with the averages of their attachment coherence scores. The mean coherence score and mean parenting score between twin pairs were found to have a moderate

correlation ($r(50) = .28, p = .048$), showing an overall family level association between coherence and parenting.

Both the Overall Parenting score between Twin 1 and Twin 2 and the Coherence score between Twin 1 and Twin 2 was found to be moderately to strongly correlated ($r(50) = .52, p < .001$ and $r(50) = .36, p = .011$ respectively). However, a large portion of the variance for parenting and coherence (.48 - .64) between monozygotic twins was not accounted for, demonstrating nonshared environmental influence on these variables. This was an important finding, indicating that identical twins are neither parented in the same way nor have the same security of attachment.

Can differences in Parenting account for differences in Coherence between MZ twins from the same family?

To test whether these MZ twin differences in attachment could be accounted for by relative MZ twin differences in parenting, we analyzed MZ twin relative difference scores on all measures of the parenting and attachment outcome. No associations were found between relative differences in parenting variables and relative differences in coherence within twin pairs. This indicated that the relationship found at a family level between higher quality of parenting and greater attachment security could not account for relative differences between twins in the same family. Therefore our hypothesis that the twin that is relatively more secure will be observed to experience a better quality of parenting than their less-secure co-twin was not confirmed.

Adjustment Outcomes

Mean adjustment outcomes for twin pairs were not found to be associated with mean coherence ($r(50) = -.01, p = .92$) or mean parenting ($r(50) = -.18, p = .20$) indicating that at a family level, twins who experienced higher quality parenting on average or greater security

of attachment did not also have better adjustment outcomes. However, the externalizing behaviour component of adjustment outcomes was found to be moderately correlated with overall parenting ($r(50) = -.29, p = .04$), demonstrating that at the family-level, twins who experienced a higher quality of parenting also presented with lower levels of externalizing behaviour on average.

To test whether MZ twin differences in adjustment could be accounted for by relative MZ twin differences in parenting and differences in attachment, we analyzed MZ twin relative difference scores on all measures of the parenting variables, adjustment and attachment outcome. No significant associations were found between relative differences in adjustment and both relative differences in overall parenting and coherence within twin pairs, indicating that these variables could not account for relative differences in adjustment outcomes between twins in the same family. The association between higher quality of parenting and lower levels of externalizing behaviour at the family level was not found within twins, and hence our secondary hypothesis that the twin with relatively better adjustment will be observed to experience better quality of parenting and attachment than their more poorly adjusted co-twin was not confirmed.

Further analysis on the joint and independent effects of attachment and parenting on the adjustment outcomes of the twins were not carried out, as no associations were found to indicate the presence of these effects.

Alternative explanations

Our study hypotheses were largely unconfirmed. The main possible explanations for these results may be considered as follows: 1) the nonshared environmental associations were present but our measures were not able to capture them; 2) the study was not able to focus on the true source of nonshared variance (i.e. the hypothesised associations were incorrect); 3) the study was exploring the correct domains, but did not

measure the relevant constructs of the nonshared environment we were examining (i.e. our hypotheses were not in the appropriate context). These explanations are discussed below.

Measures not capturing associations

Turkheimer and Waldron (2000) noted in their review of the nonshared environment research the difficulties of reliably measuring proposed aspects of nonshared variance. The problem of unreliability of measurement has been well established (Plomin 2001), making it possible that nonshared effects are not captured adequately. Measurement error may account for some of the difficulties in finding the hypothesised associations in this study. One main measure and two smaller scales were used to code for parenting in an observational task in this study. These measures were chosen carefully having examined the literature for studies which explored similar constructs. An observational task of a simulated conflict scenario was felt to provide the most accurate representation of parenting available in a time-limited space. Two of the measures used to code parenting had previously been used in a study that found nonshared environmental influence of parenting on adjustment outcomes (Scott et al., 2011), and two new subscales were introduced by the researchers: *Openness* and *Underlying Tension*. These subscales have not yet been validated and may not reliably measure the constructs they are intended to gauge. In the context of our study, it is possible these difficulties with measurement unreliability may have led to an effect that was present not being captured by the scales available, leading to the hypotheses not being confirmed.

True source of NSE not identified

Another explanation of why the associations we hypothesised were not present may be due to differential parenting *not* being a source of nonshared influence on the outcomes of the adolescents. In designing this study, a range of parental variables were selected for

examination due to well established findings implicating aspects of parenting in attachment security, e.g. maternal sensitivity and mutuality (De Wolff & van IJzendoorn, 1997). The selected variables appeared most likely to present significant associations with differences in MZ twin attachment security. It is possible instead that the relevant nonshared factors lie elsewhere. Table 2 presented the range of potential sources of nonshared environment adapted from Plomin & Daniels (1987). Other measurable sources of systematic nonshared environment, (e.g. peer relationships, sibling relationships, schooling) may potentially have greater impact on differences in attachment security and adjustment outcomes for adolescents than parenting variables. This may be understandable in the context of the changing needs of children developing in adolescence. One study found that adolescents can spend up to 35% less time with their parents than in their childhood, with that reduction being mediated by opportunities and experiences external to the family (Larson, Richards, Moneta, Holmbeck, & Duckett, 1996). Adolescence often heralds the start of gaining employment, exploring sexual relationships and expanding social relationships. These experiences will be unique to each individual, and are likely to form a part of the nonshared environment for their development. Harris (1998) made the bold assertion that “parents matter a lot less than you think” and peer influences outside of the family matter significantly more when considering sources of nonshared environment. Alongside systematic aspects of nonshared environment, nonsystematic aspects may also be relevant. Indeed, studies have even found these aspects can be *causally* linked to differences in adjustment outcome: for example, in a longitudinal MZ twin difference study, Asbury et al. (2006) found low birthweight causally linked to high levels of anxiety, hyperactivity, peer problems and low academic achievement within the twin pairs. It may be that differences in attachment security and differences in adjustment between the twins in our study may have been more linked to differences in extrafamilial nonshared environment.

Observing the correct context

Finally, it is possible that parenting variables may be very relevant to nonshared environmental influence on attachment security and adjustment outcomes, but that the contexts in which we directed our study were not the most appropriate. As children grow from infancy to adolescence, there are fundamental shifts in how attachment to their caregivers is presented and conceptualised. Cassidy and Shaver (2008) describe the concept of attachment as changing from a dyadic feature in infancy, to a more individual aspect in adolescence. In this process, attachment evolves from a construct that can be observed in behavioural and relational repertoires, to a more global cognitive system that can be assessed as a characteristic of an internal state of mind (Allen et al., 2003). As this process occurs, what adolescents require from a 'secure base' changes. In infancy, the secure base pertains to a safe haven from which the physical environment can be explored; whereas in adolescence the focus of exploration is more likely to be on their emotional and cognitive independence from their parents (Allen et al., 2003). In this sense, a secure base for an adolescent is likely to be seen in a strong relationship with their caregivers that allows and promotes the adolescents' efforts towards cognitive and emotional autonomy (Allen & Land, 1999). Studies exploring conflict and disagreement in families have demonstrated growing evidence to suggest that the ability to maintain 'relatedness' between parents and adolescents while disagreeing on critical issues as a key element of secure attachment in adolescence (Allen et al., 2003). The construct of maintaining relatedness is assessed by specific dyadic behaviours during disagreements, e.g., confidently stating one's own opinion, demonstrating empathy for the other person and validating their point of view (Moretti & Peled, 2004).

These studies suggest the possibility that while parenting variables may be critically important, the form in which these variables have an influence on attachment security may be very different to how they have previously been perceived. Another factor in the influence of parenting variables is the matter of *perception*. All systematic forms of

nonshared environment may be subject to the perception of the developing adolescent. Studies have found children's perceptions of their treatment by parents to be associated with both their attachment and adjustment outcomes (Sheehan & Noller, 2002). The perception of being or not being 'favoured' by parents may have important implications in our sample. Genetically identical twins may still perceive the same environment or event in different ways. For example, Asbury, Almeida, Hibel, Harlaar, and Plomin (2008) found MZ twins in the *same* classroom can have different perceptions of their experience in the school and classroom. In this way, shared events can have a nonshared environmental influence. In the context of parenting, this may mean for example that a mother parenting her children in the same manner can have different outcomes for each child. It is possible that apparently inconsequential matters such as a 'turn of phrase' or a particular look can have salience to one twin and not the other, leading to separate effects from the same quality of parenting. The design of our study would not be able to capture this, and so our measures of differential parenting between twins may not present any associations with differential outcomes. These differences in perceptions may be difficult to measure, but are likely to be important in how parenting can form part of the nonshared environment.

Gene-environment interactions. In using the MZ twin difference design, it is perhaps too strong to claim that the effects of genes are fully controlled for and will not have any impact on outcomes. Small events, such as what has been described above with individual perception, may lead to interactions between genes and the nonshared environment, producing separate outcomes for genetically identical individuals. Plomin et al. (2001) discuss the importance of chance occurrences contributing to nonshared environment in terms of random noise, idiosyncratic experiences and the interplay of multitudes of events. Over time, small differences in experience may be compounded and lead to large differences in outcome (Plomin, 2011). Studies have found evidence to support chance as a source of nonshared influence, demonstrating nonshared environmental effects on one

trait are largely uncorrelated with effects on other traits and nonshared environmental effects at one age are largely uncorrelated with such effects at other ages (Kovas et al., 2007; Plomin, 2011); i.e. nonshared effects are trait-specific and age-specific. These interactions would not be accounted for by the measures used in this study, making it possible that associations between important aspects of the nonshared environment and outcomes have not been represented currently.

Limitations of this study

These findings must be considered in the light of a number of limitations to the study. Primarily, our study sample was of 50 MZ twin pairs. Our power calculations indicated that our study may have been underpowered to detect effect sizes equivalent to 0.30 or below. Given the complexities of the behaviour we wish to study, it can be anticipated that effect sizes may be small when studying aspects of them (Ahadi & Diener, 1989); and so bigger samples may be necessary to examine these associations. The demographic data for the sample demonstrated that the families we observed were not fully representative of the population they were drawn from. Studies have demonstrated associations between parent-child relationship and developmental outcome may be stronger in families from poorer socioeconomic backgrounds (e.g. Seeley, Murray, & Cooper, 1996), indicating the importance of having representative samples.

The study was of a cross-sectional design. Although the main hypotheses of the study were not confirmed, the findings must be considered cautiously. Cross-sectional studies are limited in their scope as causal inferences cannot be drawn from them. Prospective longitudinal designs in future research would allow the possibility of making inferences as to the direction of effect regarding nonshared environmental influences of child outcomes.

Although the MZ twin difference design has a number of key strengths, findings from these studies may not generalise to other populations. Deater-Deckard et al. (2001) noted that the experience of parenting MZ twins may be different from raising single children from the first knowledge of pregnancy. Lytton (1977) examined differences in the variance in parenting within a MZ and DZ twin study, with results suggesting that MZ twins are parented more similarly than are DZ twins. However, the MZ twin difference design remains a powerful tool for identifying potential sources of nonshared environment.

Our measure of parenting was based largely on one measure, having observed the parent and adolescent for an eight minute interaction. Only one measure of adjustment was employed in the study. Measurement error is likely to have a greater effect when fewer measures are used. Although the individual parenting subscales that were included had acceptable ICCs (.58 - .87), the correlations between the two raters were fairly mixed and may have benefitted from greater time spent jointly training and coding example interactions. In addition to this, as the measure for adjustment is based on self-report, it is susceptible to both rater and recall bias (Cook & Campbell, 1979).

Finally, this study did not control for potential nonsystematic nonshared environmental measures like birthweight, significant events, etc. As mentioned previously, factors like low birthweight have been linked to adjustment outcomes (Asbury et al., 2006) and so could possibly have an effect on the result of the study.

Clinical and research implications

This study has shown a clear presence of nonshared environmental factors for parenting and attachment security within twins. However, it has not been able to account for relative differences between twins in the same family. A number of suggestions can be made to help future research begin to tease apart the complex interactions which may account for the nonshared environment.

Our measure of parenting was based largely on one measure, having observed the parent and adolescent for an eight minute interaction. To try to reduce the degree of measurement error in the data, it would be helpful to increase the number of observations and the number of reliable measures used on the sample. Pike et al. (1996) found significant discrepancies between different sources of data: parents' beliefs that they do not parent their children differently was found not to be accurate by other raters (e.g. their adolescents and observers), demonstrating the importance of multiple sources of data. Ratings for parental behaviours and outcomes could be taken from children, parents, teachers and observers. Similarly, observer ratings of parental behaviours or development outcomes would be free of bias found in parent ratings.

Other systematic sources of nonshared environment may be examined by taking measures of these sources, e.g., deviant peer affiliation, sibling relationships, etc. This would provide a more complete picture of the various potential influences on differential outcomes for children in the same family.

With regards to perception, this could be accessed directly by using a measure of perception of parenting, e.g., the Sibling Inventory of Differential Experience (SIDE; Daniels & Plomin, 1985) whilst also observing natural parental behaviour to examine the associations between the two measured variables. This would provide powerful data to test the notion that how adolescents perceive their treatment can lead to differential outcomes, even between MZ twins experiencing the 'same' parenting.

In considering making observations in the correct context, it may be helpful to adapt the task examining parent-adolescent interactions. The 'hot topics' paradigm used in this study was designed to simulate an argument, to examine parent and adolescent responses towards each other in a naturalistic way. However, a task designed to access the 'secure base' construct may be more appropriate for examining aspects like sensitive responding

and 'relatedness' between the dyad. For example, the task might involve the adolescent discussing a distressing experience or scenario, and how to resolve it, with their caregiver. The adolescent's behaviour and parent's response may provide very important data about how the adolescent accesses their secure base, and in what way the parent provides it.

Alongside quantitative observations, qualitative research could provide powerful data to further understand the sources of nonshared environment with genetically identical children. Caspi et al. (2004) included qualitative interviews with mothers of MZ twins to generate hypotheses about why they may treat their twins differently. Asbury, Dunn, & Plomin (2006) published a qualitative paper alongside their TEDS study of MZ twins, interviewing the 19 most discordant twin pairs and their mothers. The participants from both these papers reported factors such as negative school experiences, accidents, neonatal life events, and peer rejection as potential sources of nonshared environment.

Conclusions

In discussing the state of nonshared environment research Plomin (2011) draws an important comparison to research into genetic heritability. In molecular genetics, pleiotropy (each gene affecting multiple traits) and polygenicity (each trait is affected by multiple genes) complicate the discovery of DNA associations. In a similar way to genes, it seems likely that nonshared experiences will affect multiple traits, and individual traits will be influenced by multiple nonshared experiences. In this respect, elucidating the specific sources of nonshared environmental influences on child outcomes will continue to remain a complex task. This study demonstrated that parenting and attachment security were both influenced by the nonshared environment; however, specific aspects which accounted for differences between twin pairs were not found. Possible explanations for this were discussed and suggestions were made for further research in this area; in particular

arranging studies exploring a more attuned task of attachment security, with multiple sources of data and measures.

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Part 3: Critical Appraisal

Introduction

This critical appraisal reflects on the process of the preparation, formation and conducting of this study. It considers the ways in which the design and methods used may have impacted on findings and the influence of the researchers on this process. The complexities of translating human behaviour into measurable quantities are discussed, as well as discussing the strengths and weaknesses of the design of the study. Finally, the implications of the findings for the field are discussed.

Reflections on the research process

Prior to this research, I had been aware of the *Twins Early Development Study* (TEDS: Trouton, Spinath, & Plomin, 2002) for some time. The TEDS sample was the largest UK cohort of twins that had been studied, and a vast amount of information had been collated from their birth to adolescence. Some exciting findings have already emerged, for example, the finding that language problems at the early age of two years are highly heritable (Dale et al., 1998); or the finding of high heritability and modest shared environmental influence for hyperactivity (Price, Simonoff, Waldman, Asherson, & Plomin, 2001). The ability to examine a large sample of twins to explore differences between children raised in same family was a powerful draw. The personal experience of growing up with two siblings of very different personalities had primed me to be curious about the aspects of our environment that might be the sources of these differences. I established from my exploratory reading that although extensive research had been carried out in the field of parenting and attachment, the specific aspects of what makes two siblings grow up differently in terms of attachment security had not yet been established. It seemed striking to me that the field had yet to identify what aspects of parenting might account for differences in attachment security in children from the same family. As this research was undertaken jointly with another student, it was decided that the joint researcher would

examine the associations between parenting and attachment from a multivariate perspective looking at a sample of MZ and DZ twins (see Glazebrook, 2015), whilst I would focus on trying to find nonshared environment influences in a sample of purely MZ twins.

The first stage of our research was to establish a coding scheme for the parent-adolescent 'hot topics' task. The eight minute task between one twin and their mother had been video recorded for later coding. Scott, Briskman, Woolgar, Humayun, & O'Connor, (2011) had used this paradigm with their sample of adolescents from populations of varying degrees of risk. They carried out a factor analysis on the parenting scores from the coding scheme they employed, which led to a *positive* and a *negative* factor; and some subscales were removed from these factors due to low loadings. The study had found evidence for significant associations between adolescent attachment representations and quality of parenting, so we decided to use the coding schemes they employed. In personal correspondence with Professor Stephen Scott, it was established that they had included the scales of *sensitive responding* and *mutuality* from the Coding of Attachment-Related Parenting (CARP: Matias, Scott, & O'Connor, 2006). We also included these subscales, and watched some sample video recordings of the interactions. This was the most complex stage of the study for us, as detailed below.

The difficulties of coding human behaviour

Watching the video recordings made it clear that the task of coding parenting behaviours and adolescent responses would not be a simple one. Our task was to quantify variables based on observations of dynamic, fleeting, multi-faceted behaviours. These scores would then be used to correlate against scores of the adolescents' attachment security to determine their predictive power. Our judgements on these codings were subject to a number of different factors, including: whether the 'hot topics' task elucidated a true picture of parenting from the caregiver; the impact of the researchers' subjectivity

on the interpretation of the observations; and the effect of the process of analysis of the coded observations. Each of these were considered carefully when carrying out the coding.

Once we started viewing sample recordings, we were largely impressed with the interactions within the dyads on the 'hot topic' task. It appeared to have a reasonably good effect in creating mild conflict scenarios, which seemed to create natural and genuine reactions in both the adolescent and the parent. Some adolescents (and parents) appeared to not engage with the task at all, behaving disinterestedly or disingenuously. However, we took this to be useful information and considered if our current coding scheme was equipped to capture this disengagement. The awareness of being filmed and the researchers' presence in their proximity is likely to have led to a degree of *observer effect*; for example, the dyad may have appeared anxious or parents may be on their 'best behaviour' during the task. During the interactions, although some dyads were initially wary of the camera and appeared somewhat awkward, most dyads were able to focus on the task and appeared to act more naturally as time went on. The ease at which they were able to engage with the task together provided us information about the quality of their relationship. We were aware of the issue of time: in an eight minute interaction, we were attempting to measure 15 aspects of parenting (and also 16 aspects of the adolescent's behaviour). Some of these aspects of behaviour simply did not present themselves to a significant degree, e.g. *assertiveness*. If a dyad had an 'easy' interaction with each other, and the skill of assertiveness did not have a particular role in their dialogue; we discussed whether this meant that we should score them lowly on the dimension, thus scoring them in the same way we would score an individual with poor assertiveness skills. This appeared to be a particularly troubling conundrum with the parenting dimension of *sensitive responding*, as the task gave little scope for a parent to respond to verbal and non-verbal cues of emotional needs as per the coding manual (see Matias et al., 2006). Where there was doubt, we chose to pay careful attention to the "responsive engagement" and

“sensitive child mindedness” aspects of the sensitive responding subscale, as well as giving a middling score for parents that did not *fail* to provide a sensitive response but also did not show strong examples of the dimension.

Creating new scales

In the initial stages of sampling the recordings, it was felt that there were some aspects of the interactions not being fully captured by the measures we were testing. However, deciding what aspects were not being represented in the scales proved a difficult task. In viewing interactions for both twins in a pair and their mothers, we noticed that there were instances where there were differences in the quality of interactions as well as co-occurring differences in the twins’ attachment securities. In other words, even within monozygotic twin pairs, the mothers behaved differently with each twin and there appeared to also be differences in how securely attached these twins were. We considered various aspects of the interaction, for example, eye contact and maternal empathy towards the adolescent. It was felt that two aspects, which we entitled *Openness* and *Underlying Tension*, adequately captured what we were observing. Putting words to scores on the scale of both these items proved a challenging task; particularly for Underlying Tension, in each we were attempting to code subtle, covert interactions in the dyad. However, it was reassuring that while coding our reliability set, the two novel scales appeared to be measures we were scoring fairly reliably between raters.

As we coded more interactions, the matter of subjectivity became an increasingly obvious issue. In our discussions regarding the interactions we were viewing, we found our own personal experiences being a feature of our conversations. Our historical experiences of being parented and our own opinions on ‘reasonable’ parenting (e.g. regarding computer usage and social lives, which many parents and adolescents talked about) were very much part of our judgements on the interactions. We were able to reflect upon these issues, and

consider whether prejudice was something that might also affect our judgments: for example, we wondered whether we were judging parents from lower socioeconomic backgrounds to have poorer communication. The discussion of differences of opinion tended to lead to a more uniform approach to coding.

To establish inter-rater reliability, we coded a set of 20 video recordings independently. We discussed each of these at length regarding the quality of the interaction, how well the subscales were capturing what they intended to measure, borderline and unclear cases, etc. We identified 'prototypic' examples of interactions which demonstrated particular subscales for future reference. We found it helpful to refine the wordings of some of the subscale scoring guides, to make distinctions between scores clearer. These discussions and further reading led us to exclude two subscales: *authority/control* and *self disclosure*. In the initial stages, our inter-rater reliability was often lower than we hoped. This highlighted to me the role of perception on how a behaviour may be internalized; also linking to my discussion of the role of perception in parenting acting as a nonshared environmental factor between identical twins. Independently coding the main set was somewhat daunting at first. In trying to remain objective whilst coding independently, we sometimes found ourselves thinking, "what would the other researcher rate this?" on particularly tricky cases. However, subjective decisions regarding these tricky cases had to be taken on our own. Revisiting some cases later out of curiosity sometimes led to consideration as to whether I was being 'too harsh' or 'too lenient', and what might be the factors behind that.

We continued to carry out reliability codings for every 10 videos that we coded. We also discussed these in depth to monitor rater drift, and felt sure we were seeing differences attributable to our created measures. Our ICCs remained steady, with some improvements and some reductions. At the end point of our coding, we felt fairly confident in the design of our scales, and the approach we took to coding the interactions.

Personal experience of coding

The experience of coding was engrossing and genuinely enjoyable. It felt remarkable to be able to observe the 'live' interactions between a parent and her genetically identical children, and yet still see differences in how she approached them. Although these observations were fascinating, I was wary of the power of my judgement on these interactions: on occasion I found myself marking a parent poorly in particular domains and wondering with some guilt, "could I do a better job?". In the initial stages, we checked the attachment statuses of the twins we observed on the recordings. There were a number of occasions when I was very surprised by the classifications; when I had felt strongly that the interaction we were viewing was of a secure child with a warm mother, or an insecure child with a rejecting mother. I can recall watching a mother with very flat affect, whom I assumed to potentially have a poorly attached child; and a mother who made a number of very critical remarks and then ignored her child for the rest of the interaction, whom I also assumed to have a poorly attached child. On both occasions I was incorrect: the children were securely attached to their mother. As a clinician, this was a revelation. It impressed upon me the importance of reflecting of my own judgement and keeping an open mind as to what constitutes a 'good' parent, especially if I am able to observe only a snapshot of the daily life of a family. This research has had a broader effect on my clinical work in this sense; as I have been left feeling that we are yet to know specifically what makes a parent a 'secure base' and what role the child may have in creating this. My future experiences of interventions with families are likely to be more flexible in this sense.

Strengths and weaknesses of the study

As a whole, the study felt well designed and rigorously conducted. Upon analysis of the findings, some possibilities for improvements and further research were considered.

Design and data analysis

The MZ twin difference design has been described as an “unambiguous tool” for examining the nonshared environment (Pike, Reiss, Hetherington, & Plomin, 1996). As MZ twins brought up in the same family are genetically identical, their differences in experience and in outcome can only be due to nonshared environment and measurement error. The possibility of observing ‘pure’ nonshared effects continues to make this a highly attractive design for exploring the environmental antecedents of attachment security and adjustment outcomes. The analysis of the findings was carried out through examining relative differences scores between MZ twin pairs. Some commentators have cautioned about the limitations of this design and analysis as it ignores between-pair variance and total variance among individuals (Plomin, 2011). Full multivariate genetic designs, including MZ and DZ twins, allow for examination of variance within and between twin pairs, as well as the exploration of genetic and shared environment influence. Including DZ twins in the analysis provides a replication and a check on the uniqueness of MZ twins; as DZ twins should show nonshared environmental influences on examined variables equivalent to or greater than MZ twins (Plomin, 2011). This design may be useful for future research in considering differences between families as well as differences within families.

In carrying out the statistical analysis for the results, I was cautious not to over-analyse data: I was wary of my disappointment with no confirmation of my hypotheses, and wished to avoid ‘mining’ the data for associations and increasing the likelihood of Type I error.

Coding scale reliabilities

Although our attachment and adjustment outcome measures were well-established validated and reliable measures, our parenting coding scales were less so. The inter-rater reliabilities were at times lower than hoped, and eventually we had to remove one of the

subscales, *parent communication*, as it fell below an acceptable ICC. Further training and discussion, along with having more than two coders, may have led to better inter-rater reliability scores. However, this was not possible during this study.

Sample size

The complications of putting together coding schemes which we felt confident in took a significant amount of time. Although this was a crucial stage of the research, it reduced the amount of time we had available to code the main set of recordings we had access to. Ideally, we would have coded a larger sample, providing the study with greater power to detect smaller effects, as discussed in the methods section.

Clinical and research implications

On the basis of this study, the question of parental antecedents of attachment security still requires further research to establish clear associations. Suggestions for future directions for research were discussed, focussing on the possible reasons why our hypotheses were not met and ways to explore these alternative explanations.

My literature review pointed to the importance of conducting prospective longitudinal studies when researching this field. Increasing evidence demonstrated the bidirectional influence of parental behaviour and child outcomes, indicating that cross-sectional observations may provide an inadequate picture.

The role of perception

Perhaps the most striking aspect of observing the video recordings was the role of perception in our own judgement of the quality of the interaction and parenting. At times it felt my decisions on the scoring were somewhat arbitrary, or based on emotional instincts regarding what was observed. The role of perception was discussed in regards to how

children process parental behaviour: a child is likely to be influenced by their own historical experiences of events they have observed and encounters with their parents when internalizing these experiences. In other words, no two children will be alike in how they 'see' their parents and experience parenting, even if they are genetically identical. The study was not able to capture what felt like an extremely important element of how parenting may impact upon a child. In future, a study designed to capture *perception of parenting* within a MZ twin difference design would provide very useful information in this regard. For my literature review, one of the most engaging papers I read was by Caspi et al. (2004), an MZ twin difference study which incorporated qualitative interviews with mothers of MZ twins to generate hypotheses about why they may treat their twins differently. Another paper, (Asbury, Dunn, & Plomin, 2006) interviewed both MZ twin pairs and their mothers. These interviews revealed fascinating insights into the role of life events and minor chance occurrences which were felt by the interviewees to potentially be the cause of differences between the twins and the parenting of the twins. It would be very helpful for future research to involve an element of qualitative data, to gain a fuller perspective as to the potential causes of differences between twins. It may also be possible to extract thematic categories from this data, aiding in the design of new scales or structured interviews that may be able to capture these differences.

Conclusions

As I have progressed through the various stages of this research, I have gained invaluable insight into the varying challenges of finding ways to conceptualise, observe and measure the construct of 'parenting', and its related outcomes. Although clear differences were found for how identical twins within a family were parented and how securely attached they were, the constructs I measured in terms of the way they were parented did not reveal the source of these differences. Our challenge continues to be in finding robust ways

to measure these differences in order to create an evidence base, develop our theoretical understanding, help inform policy, and use this understanding to target clinical interventions for at-risk groups. In the light of the findings of our study, it seems particularly important to consider alternative aspects of the studied variables and consider in a fresh way the question Plomin and Daniels (1987) put to the field almost 30 years ago: why are children in the same family so different?

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Appendices

Appendix 1: Summary table of literature review studies

Table 10: A summary of the design and variables measured in the selected studies.

Authors	Sample characteristics	Design	Parenting			Outcome		
			Age	Measures	Variables measured	Age	Measures	Variables measured
Pike et al., 1996	93 MZ twin pairs from the Nonshared Environment and Adolescent Development (NEAD) Project [UK]	Cross-sectional	10-18 years	PDB, PCD, and PCR from Global coding system (Hetherington & Clingempeel, 1992) and Conflict Tactics Scale (Straus, 1979)	Maternal and paternal negativity	10-18 years	Child Depression Inventory (CDI; Kovacs, 1983); Behaviour Problems Index (BPI; Zill, 1985); Behaviour Events Inventory (BEI; Patterson, 1982)	Internalizing and externalizing behaviour: Depression and antisocial behaviour
Deater-Deckard et al., 2001	62 MZ twin pairs [UK]	Cross-sectional	3.5 years	Parent-Child Interaction System (PARCHISY; Deater-Deckard, Pylas & Petrill, 1997); global coding system of harshness of discipline (Deater-Deckard, Dodge, Bates & Pettit, 1996); Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996)	Harsh discipline; negativity; positivity; positive control; negative control; responsiveness; on-task behaviour	3.5 years	Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997); Colorado Childhood Temperament Inventory (CCTI; Rowe & Plomin, 1977)	Socio-emotional adjustment: SDQ Total Problems; CCTI Emotionality; SDQ Prosocial scores Behaviour: Positivity; negativity; on-task behaviour; noncompliance; activity; responsiveness
Caspi et al., 2004	565 MZ twin pairs from the Environmental Risk (E-Risk) Longitudinal Study [UK]	Longitudinal	5 years	Five-Minute Speech Sample (Magaña et al., 1986)	Expressed emotion: Positive comments; negative comments; negativity; warmth	5 and 7 years	Child Behavior Checklist (Achenbach, 1991a); Teacher Report Form (1991b)	Antisocial behavioural problems
Mullineaux et al. 2009	77 MZ twin pairs	Longitudinal	4-8 years	Parent-Child Interaction System (PARCHISY; Deater-Deckard et al., 1997); Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996)	Observer rated positivity and negativity; mother rated positivity and negativity	4-8 years	Child Behavior Checklist (Achenbach, 1991)	Negative behaviour; positive engagement; externalizing and internalizing behaviour
Asbury et al., 2003	2353 MZ twin pairs from the Twins Early Development Study (TEDS)	Cross-sectional	4 years	Global coding system of harshness of discipline (Deater-Deckard, Dodge, Bates, & Pettit, 1998); Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996)	Harsh discipline; negative feelings	4 years	Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997)	Anxiety; prosocial behaviour; hyperactivity; conduct problems

Liang & Eley, 2005	328 MZ twin pairs from the GENESiS1219 Twins project [UK]	Longitudinal	12-19 years	Negative Sanctions and Communication About Discipline subscales from Global coding system (Hetherington & Clingempeel, 1992)	Maternal and paternal punitive discipline; maternal and paternal constructive discipline	12-19 years	Moods and Feelings Questionnaire (MFQ; Angold & Costello, 1995)	Depression
Shields & Beaver, 2011	289 MZ twin pairs from the National Longitudinal Study of Adolescent Health (Add Health) [US]	Longitudinal: cross-lagged and reciprocal effects model	11-18 years	Maternal disengagement scales, attachment scales, involvement scales.	Maternal disengagement; attachment; involvement	Four waves over 13 years	Centre for Epidemiological Studies Depression scale (CES-D; Radloff, 1977)	Depression
Guimond et al., 2012	137 MZ twin pairs from the Quebec Newborn Twin Study (QNTS)	Longitudinal	2.5 years	Parental Cognitions and Conduct Toward the Infant Scale (PACOTIS; Boivin et al., 2005)	Maternal and paternal overprotection; maternal and paternal hostility	2.5 years	Observational task adapted from Movie Viewer Situation (MV; Charlesworth & LaFreniere, 1983)	Social reticence
Spanos et al., 2010	234 female MZ twin pairs from the Minnesota Twin Family Study (MTFS)	Longitudinal	11, 14 and 17 years	Parent-Child Conflict Scale from Parental Environment Questionnaire (PEQ; Elkins et al. 1997)	Parent-child conflict	11, 14 and 17 years	Minnesota Eating Behavior Survey (MEBS; Garner et al. 1983)	Disordered eating
Kendler & Gardner, 2001	72 female MZ twin pairs [US]	Cross-sectional	30.3 years	Parental Bonding Instrument (Parker et al., 1979)	Maternal and paternal warmth; protectiveness; authoritarianism	30.3 years	Lifetime prevalence of Major Depression using Diagnostic and Statistical Manual criteria (DSM-III-R; American Psychiatric Association, 1987)	Lifetime prevalence of Major Depression
Viding et al., 2009	2254 MZ twin pairs from TEDS	Longitudinal	7 years	Global coding system of harshness of discipline (Deater-Deckard et al., 1998)	Negative parental discipline	7 and 12 years	Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997)	Conduct problems; callous-unemotional traits

Cecil et al., 2012	2092 MZ twin pairs from TEDS	Longitudinal: cross-lagged model	3, 4, 7, and 9 years	Global coding system of harshness of discipline (Deater-Deckard et al., 1998); Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996)	Harsh parental discipline; negative parental feelings	3, 4, 7, 9, and 12 years	Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997)	Self-control; emotional problems; conduct problems
Asbury et al., 2006	2017 MZ twin pairs from TEDS	Longitudinal	4 years	Global coding system of harshness of discipline (Deater-Deckard et al., 1998); Parent Feelings Questionnaire (PFQ; Deater-Deckard, 1996); Instructive parent-child communication; Informal parent-child communication	Harsh parental discipline; negative parental feelings; instructive parent-child communication; informal parent-child communication	7 years	Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997); teacher ratings of child performance on the UK National Curriculum (QCA, 1999)	Anxiety; prosocial behaviour; hyperactivity; conduct problems; peer problems; academic achievement
Burt et al., 2006	486 MZ twin pairs from MTF5	Longitudinal: cross-lagged model	11, 14 and 17 years	Parent-Child Conflict Scale from Parental Environment Questionnaire (PEQ; Elkins et al. 1997)	Parent-child conflict	11, 14 and 17 years	Assessment of mental disorders using Diagnostic and Statistical Manual criteria (DSM-III-R; American Psychiatric Association, 1987); assessment of CD and ODD using Diagnostic Interview for Children and Adolescents-Revised (DICA-R; Reich & Welner, 1988)	Externalizing symptoms
Yamagata et al., 2013	259 MZ twin pairs from ToTCoP	Longitudinal: cross-lagged and reciprocal effects model	42 months and 48 months	Self-report measure from Yamagata (2011)	Consistent discipline; harsh parenting; authoritative parenting	42 months and 48 months	Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997)	Peer relationship problems

Guo et al., 2011	585 MZ twin pairs from BeTwiSt	Cross- sectional	11-18 years	Scales adapted from Iowa Youth and Families Project (Conger, Patterson, & Ge, 1995)	Nurturant-involved parenting; harsh- inconsistent parenting; maternal warmth; maternal hostility	11-18 years	Early Adolescent Temperament Questionnaire-Revised (Ellis & Rothbart, 2001)	Effortful control
Hou et al., 2013	520 MZ twin pairs from BeTwiSt	Longitudinal: cross-lagged model	10-18 years	Scales adapted from Iowa Youth and Families Project (Conger et al., 1995)	Parental warmth and parental hostility	10-18 years	Youth Self-Report Inventory (YSR; Achenbach & Rescorla, 2001)	Aggressive and delinquent behaviour

Appendix 2: QualSyst checklist

[Removed for copyright reasons, please refer to Kmet, Lee, & Cook (2004)]

Appendix 3: ‘Hot Topics’ instructions

Introducing the Parent-Adolescent Discussion Task and Selection of Topics for Discussion

I will be videotaping you and your mum talking about a disagreement that you have. Before we bring your mum in here, I want you to select topics you'll discuss with her. Here is a list of different areas that teens and parents often disagree about.

GIVE LIST

Look over the list and circle the 2 topics that you and your mum disagree about the most. Keep in mind that these topics concern your behavior, not someone else's, for example, your friends'.

THEY SELECT TOPICS

Do you think your mum also sees these as areas of disagreement between the two of you?

IF THE TEEN SAYS NO, ASK THEM TO SELECT OTHER TOPICS

Which one is the bigger source of disagreement? I want you to discuss that issue with your mum first.

(If the teen does not or cannot identify any areas of disagreement, talk to the teen about any possible areas that they might disagree about, either from our list or otherwise. Stress that we are not looking for something they have huge arguments about, just some area about which they don't agree. Ask the teen to recall a disagreement they had with their mum in the past 2 weeks. If the teen can't or won't name an area, tell the teen the discussion with the parent should focus on how decisions are made in their family about the teen's activities outside of school and whether the teen and parent have differing views on this.)

If You Will Be Videotaping a Second Parent-Adolescent Interaction

PULL OUT A SECOND COPY OF THE LIST OF TOPICS

After we videotape the discussion with your mum, we want to videotape you and your dad talking together about a disagreement that the two of you have. Look over this list again and circle two topics that you and [your father] disagree about the most.

REPEAT INSTRUCTIONS ABOVE

Giving Teen Instructions for Initiating the Discussion Task

To start the discussion with your mum, I'll be asking you to describe the major disagreement that you have about the topic you chose. Start by stating your side of the disagreement and then what you see as your mum's side. The two of you will then discuss the disagreement and try to reach a resolution you're both happy with. Is it clear what you'll be doing?

Now I'm going to bring your mum in here to hear the instructions and then I'll leave and you can begin.

BRING FIRST PARENT INTO THE TAPING AREA AND START THE VIDEO RECORDING

Giving Instructions to Both Parent and Teen to Initiate the Discussion Task

We are going to videotape the two of you as you discuss areas of disagreement. We want you to feel as comfortable as possible doing this, so I'll leave the room during your discussion. I've asked to identify two topics from a list that teenagers and their parents often disagree about. will start the discussion with you by telling you the disagreement they've said the two of you have and describing their side of it. will then describe their view of your side of the issue. I'd like the two of you to talk about this issue for 8 minutes, so take the time to talk about both sides of the disagreement. You should each try to help the other really understand your side of the disagreement and then try to reach some resolution to the issue that you are both happy with. Any questions?

TURN TO TEEN

If you finish discussing the first topic, move to the second topic you identified, and talk about it in the same way. I'll come back when the 8 minutes are up. I'm leaving a card with instructions on it in case you need it.

POINT TO INSTRUCTION CARD; DO NOT LEAVE THE LIST OF TOPICS IN THE ROOM

Here are cards with the topics you chose just to remind you. The first topic is the card on top

GIVE CARDS TO TEEN

Any questions?"

To Initiate Second Parent-Adolescent Interaction

BRING SECOND PARENT AND ADOLESCENT BACK TO THE LOCATION WHERE THE FIRST INTERACTION WAS FILMED AND START THE VIDEO RECORDING

For this activity, we are going to videotape the two of you as you discuss areas of disagreement. We want you to feel as comfortable as possible doing this, so I'll leave the room during your discussion. I've asked to identify...

(proceed as above, but acknowledge that the teen has heard these instructions before and shorten accordingly).

Here is a list of different areas that teens and parents often disagree about. Look over this list and circle the **two** topics that you and your ... disagree about the most. Keep in mind that these topics concern **your** behaviour, not someone else's (for example, your personal appearance, not your friends' personal appearance).

Money

Friends

Grades/Schoolwork

Chores

Alcohol and drugs

Dating

Brothers or sisters

Religion/Going to church/participation in religious activities

Phone

Personal appearance (clothes, haircuts, etc.)

Use of computer

Videogames

Music

Sleep habits

Rules in your house

Activities outside of school

1. Describe the disagreement you have with parent.
2. State your side of the disagreement.
3. State your parent's side of the disagreement
4. Discuss the disagreement so that you both understand each other's point of view.
5. Try to resolve the disagreement
6. If you finish discussing first disagreement before time is up, talk about the second disagreement, and repeat steps 1-5.

You have 8 minutes for your discussion.

MONEY

FRIENDS

**GRADES/
SCHOOLWORK**

CHORES

**ALCOHOL &
DRUGS**

DATING

**BROTHERS &
SISTERS**

Religion/Going to
church/participation
in religious activities

PHONE

**Personal appearance
(clothes, haircuts,
etc.)**

**USE OF
COMPUTER**

VIDEOGAMES

MUSIC

SLEEP HABITS

**RULES IN YOUR
HOUSE**

**ACTIVITIES OUTSIDE
OF SCHOOL**

Appendix 4: New parenting scales

Openness

Openness refers to the quality of the interaction from the parent to the child and vice versa. It describes the degree to which a genuine, open and comfortable interaction is demonstrated in the dyad.

Operationalisation

Examples

a) Ease

Interactions are characterised by a sense of ease and comfort from the parent/child. The parent/child appears to be open with the other's presence and does not seem an unwilling participant in the conversation. Despite potentially negative statements or exchanges there is an overall sense of ease. Playfulness and humour may also be apparent; designed to lighten the mood or indicate a 'good will' towards the other.

b) Openness/transparency

Openness is used to facilitate the discussion of difficult topics. The parent/child is willing to honestly discuss their viewpoint in order to express their difficulties and needs. They do not acquiesce to the other and stymie their opinion simply to avoid conflict or conversation.

Scores

1- No openness

Note: There is a complete absence of ease and comfort or openness: the parent/child is uncomfortable in the other's company and may appear tense or uneasy. They are withdrawn from the conversation and do not appear to be a willing participant in the conversation.

2- Minimal openness

Note: There may be one or two examples of openness, e.g. one or two instances of playfulness. However, the degree of pervasiveness and degree of intensity indicate that predominantly there is no openness with the other.

3- Slight openness

Note: To score a 3, the parent/child will show some scattered evidence of openness, but this will not constitute a strong/ obvious sign of openness on their part.

4- Somewhat open

Note: The intensity/frequency in which openness is displayed is balanced by the intensity/frequency by which a lack of openness is displayed. Thus, several examples of ease and goodwill towards the other will be balanced with several examples of lack of openness and withdrawing from the conversation. The overall effect will be that the parent/child will partly display openness and partly display a lack of ease with the other.

5- Good openness

Note: There is an overall pattern in which open behaviours are greater/more prominent than a lack of ease. Thus the general sense is of ease or openness with the other. This is offset by modest and infrequent examples of unease and a lack of openness with the other.

6- Very good openness

Note: There is a consistent pattern where openness is displayed toward the other. They consistently show signs of openness; and mild evidence of unease and a lack of openness.

7- Extreme openness

Note: The parent/child either displays all the above criteria or those that are displayed must be extreme manifestations of openness. The various types of open behaviours are pervasive and unambiguous to the observer.

Underlying Tension

Underlying Tension refers to situations where the discussion between parent and child seems strained and both sides appear reluctant to change their own ideas or demands. There is a sense that both parent and child seem equally determined to get what they want, with little room for compromise, i.e. there is a *battle of wills*. This scale codes for more subtle interactions and tension rather than overt conflicts.

Operationalisation

Examples

c) Underlying tension

This relates to there being a strained relationship between the parent and the child. There is uneasiness between the two which suggests that not only do they have different views on the topic of discussion but that neither person is very open to compromise and the result is a 'battle of wills'. There is a lack of flexibility from both sides and they seem uncomfortable with each other. Examples might be half-heartedly agreeing to a solution, interrupting each other or responding in brief, terse words.

d) Resistance

There is frequent opposition to the others requests, suggestions or ideas. There is a lack of enthusiasm for the other's view point and a refusal to accept an alternative position. There is an underlying struggle between the pair, which may lead to displays of irritation. In the case of parents, there might be resistance to the child's quest to become autonomous and independent. In the case of children, they may ignore what the parent is saying rather than choose to debate an issue. There is the sense that one is hoping that the other will simply back down, rather than negotiate.

e) Dismissing/ disengaged

This refers to minimising or dismissing the others ideas, opinions or expressions of emotions. One may view the others views as unimportant or trivial and shows little interest in them or may ridicule or make light of their opinions. Emotions are seen as demanding and difficult to manage. The dyad does not find concrete solutions to the problem as they believe that the problem is irrelevant or will go as time pass by.

f) Falseness

When expressing opinions or attempting to reach a solution there is a lack of conviction in what is being said. What is expressed appears disingenuous or lacks sincerity. There seems to be a falseness or a "front" that is being put on during discussions, which makes the interaction appear forced or awkward.

Scores

8- No underlying tension

There is an absence of tension, strain, resistance, disengagement and falseness.

9- Minimal underlying tension

The degree of pervasiveness and degree of intensity (e.g. one or two examples of minor resistance) indicate that predominantly there is no underlying tension between members of the dyad.

10- Slight underlying tension

To score a 3, the parent and child will show some scattered evidence of underlying tension, but this won't constitute a strong/ obvious sign of a struggle between the two.

11- Somewhat underlying tension

The intensity/frequency in which underlying tension is displayed is balanced by the frequency by which these behaviours are not displayed. Thus, several examples of underlying tension will be balanced with several examples of comfortable, flexible and accepting behaviour. The overall will be that the dyad is a pair that partly engage in a battle of wills and partly engage in accommodating and tolerant behaviour.

12- Moderate underlying tension

There is an overall pattern in which underlying tension behaviours are greater/ more prominent than comfortable and accommodating behaviours. Thus, the general style is tense, resistant, disengaged or false. This is offset by modest and infrequent examples of comfortable and accepting behaviours.

13- Definite underlying tension

There is a consistent pattern where episodes of underlying tension behaviours are displayed. The parent and child consistently show signs of tension, strain, dismissing and disingenuous behaviour, and mild evidence of comfortable and accepting behaviours.

14- Extreme underlying tension

The parent and child either display all of the above criteria or those that are displayed are extreme manifestations of underlying tension behaviours. The various types of underlying tension behaviours are pervasive and unambiguous to the observer.

Appendix 5: Joint thesis statement

Joint Thesis Statement

This thesis formed part of a joint project carried out in conjunction with another researcher (Glazebrook, 2015). The work that was carried out in conjunction with the other researcher included establishing the coding schemes and creating two new scales as described in the methods section, and coding the video recordings of the parent-adolescent dyads. A sample was of 50 MZ and 50 DZ twins were jointly coded by the researchers for the main dataset, as well as an extra 30 MZ and DZ twins for the purposes of reliability. The twins from each pair were randomly assigned Twin 1 and Twin 2, and the researchers were randomly allocated one twin to code; therefore, each researcher coded half the sample. Glazebrook (2015) carried out a factor analysis for the parenting variables, which was later used in this study. Only the MZ twin codings were used in this study, whilst Glazebrook (2015) used the data for the whole sample. All other research, analysis and writing up was carried out independently.